Co-design toolkit

for users to participate in the early stage of automotive design

Master of Arts Thesis
2020

Xiaoyi Cheng

Collaborative and Industrial Design Programme

Department of Design
Aalto university School of Arts, Design and Architecture

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Supervisor
Andrés Lucero

Advisor
Andrés Lucero

Aalto University
School of Arts, Design
and Architecture

Aalto University, P.O. BOX 31000, 00076 AALTO
www.aalto.fi

Master of Arts thesis abstract

Author Xiaoyi Cheng

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Abstract

Currently, automotive design is technology oriented. Because of the fast-paced lifestyle, users can spend a significant amount of their leisure time in the vehicle. With the development of technology, traditional automotive design is changing step by step. In the future, the vehicle will not only be the means of transportation but will also become a living space. Therefore, the potential demands of the users create novel design opportunities in the automotive design field. At present, users are mainly involved in the concept assessment and usability test; the gap between users and automotive design still exists. To dig the users' needs more in-depth, and give everyone an opportunity to speak, co-design may be a practical way to engage users in the early stage of automotive design.

Therefore, the goal of this thesis is to engage users and propose a co-design toolkit for them to participate in the early stage of automotive design.

This thesis consists of research and design. The literature review and desktop research build the theoretical framework for the design of the toolkit, while the interviews provide insights into the attitudes of engaging users in automotive design from the experts' views. In the design stage, the toolkit is iterated twice, and the co-design workshops were conducted with 28 participants. The toolkit includes positive emotion cards, negative emotion cards and experience tasks, which assist the users in building a common language, recalling previous in-vehicle experiences and generating new ideas. Because this thesis is supported by GAC G&D Centre, which is a Chinese automotive design company, the data research is based on the Chinese market, and the workshops were held in China.

The analysis of the workshops demonstrates that with the help of the toolkit, the participants actively shared stories and expressed expectation. In the toolkit, positive and negative emotions served as triggers to dig deeper into users demands. Moreover, the outcomes of the workshops reveal the present problems and expectations of each experience and list the proposal for future automotive design.

Keywords co-design, toolkit, user engagement, automotive design, emotion

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1. Introduction

1. 1 Background of the topic

User engagement is essential in design development. However, the research conducted by François, et al. (2017) indicates that for a long time, automotive design has been technology oriented; and in the automotive design field, there is a lack of awareness of engaging users in the early stage of design. Last year, I had the opportunity to have a short time internship in a Chinese automotive design company, GAC R&D Center. Working in the Experience and Interaction Design Department, I found that the research methods used in the company are conventional and lack of user engagement. Generally, in the company, the market researchers take the responsibility of collecting customers' needs. They will deliver the findings to the designers, and the designers are responsible for innovating based on the marketing research results and the company strategy.

Currently, in automotive design, user engagement is gradually being realized (François, et al., 2017). However, in most cases, users are engaged in a usability test, which means users are only engaged in the feedback section rather than the design process (François, et al., 2017). However, participatory design claimed that people should have the chance to affect it if they are influenced by the decision (Schuler and Namioka, 1993; Visser, et al,. 2005). In the future, with the development of technology, a vehicle will not only be the means of transportation, but it will also become a movable space and create more design opportunities to improve the using vehicle experiences (Goldman Sachs, 2015). Therefore, to engage users and excavate users' expectations in automotive design, the main objective of this thesis is to design appropriate tools and activities for users to transfer design competence.

This thesis is supported by GAC R&D Center, which is a Chinese automotive design company. The data and research are based on the Chinese market. To narrow the scope, this thesis will focus on the experiences and expectations of car usage scenarios, rather than discuss the aesthetic and technical development of the automotive design.

1.2 Objectives

1.2.1 Research objectives

Starting from clarifying the importance of user engagement in design, mainly engage users in the early stage of automotive design. This thesis aims to develop co-design toolkit for users to participate in the early stage of automotive design session. The toolkit could assist the users in recalling their previous experience, map out the context and generate ideas. Therefore, users can be heard in the early stage of design, and designers can get inspiration directly from users to better meet market expectations. Important to realize, this thesis will focus on the experience of car usage in previous time and users' expectations of future scenarios, instead of the automotive-style design.

1.2.2 Company objectives

In the company, the Experience and Interaction Design Department is trying to update its research methods. The research outcome will be the co-design toolkit which can be applied in the early stage of the automotive design and the toolkit will be valuable for the company to better understand user experience by using co-design methods. Also, listening to users' voices and getting inspiration from them is beneficial for the company to meet the market expectations better (Mustak, et al., 2013). Besides, the innovative design methods are more effective than traditional UCD methods for creating profitable offerings (Lee.J, et al. 2011). It can help the company reduce the cost of iteration and improve a stronger customer-seller relationship (Mustak, et al., 2013).

1.2.3 Personal objectives

During the short-term internship in the automotive design company, I got interested in in-vehicle design which is a novel field for me. While working with the design research team, I found that the research methods that they are using are quite conventional and limited. The initial ideas only come from a small research group, including UX designers and marketing researchers. Customers, users, and stakeholders will not participate in the brainstorming step; they are only involved in the feedback session. Through a year of study, now I get plenty of insights into co-design and willing to apply them in practice. I found that the co-design method can inspire and innovate the company’s current research methods.

1.3 Research questions

The main question is:

(1) How to encourage and facilitate users to participate in the early stage of automotive design ?

The sub-questions for the main research questions are:

a) Why are users needed to be engaged in the early stage of automotive design ?

b) What kinds of co-design tools and activities will be appropriate for engaging users in the early stage of automotive design ?

The figure below visualises the research questions.

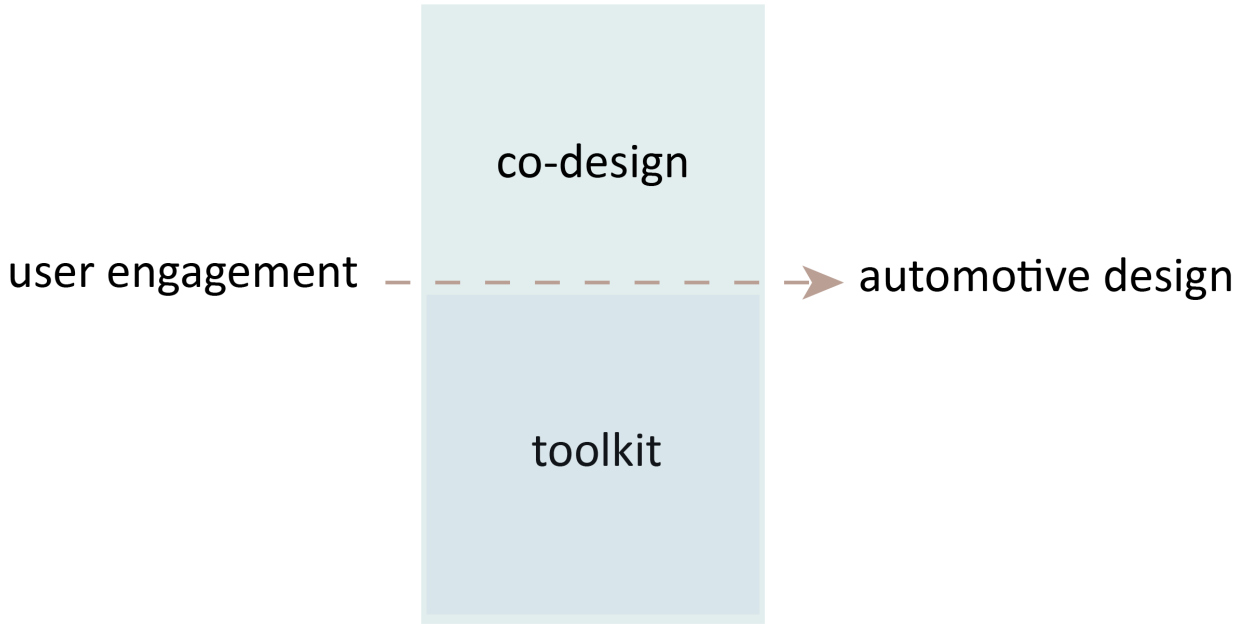


Figure 1. *The goal of this thesis is studying how to apply co-design toolkit in automotive design to engage users.*

1.4 Research methods

The research methods are divided into qualitative research methods and testing methods. In the qualitative research, firstly I did the literature review to obtain a deeper understanding of co-design methods and clarify the necessity of engaging users in automotive design. Secondly, browsing some forums and reading reports to have a basic understanding of future automotive design. Thirdly, emphasize emotions that enable the users to convey their experiences and expectations by studying the research of emotional granularity. Then I had interviews with experts to understand their vision for the future automotive design and their views on user engagement. The experts include UX designer, interaction designer, technology expert, and market researcher. After the desktop research and interviews, I analyzed the data by categorizing the findings and insights, then summarised them into different potential future scenarios.

In the testing methods, firstly based on future scenarios, I designed the toolkit prototype and ran a pilot test. Then, I invited users with different backgrounds to participate in co-design workshops. The participants freely chose their exciting topics and worked on it in a small group. The workshops were held several times to evaluate and iterate the toolkit. After the workshops, I asked the participants' comments on the toolkit and the workshops. Finally, summarised the outcomes from the workshops and analyzed the evaluation of toolkit. The figure below illustrates the project timeline (Figure 2).

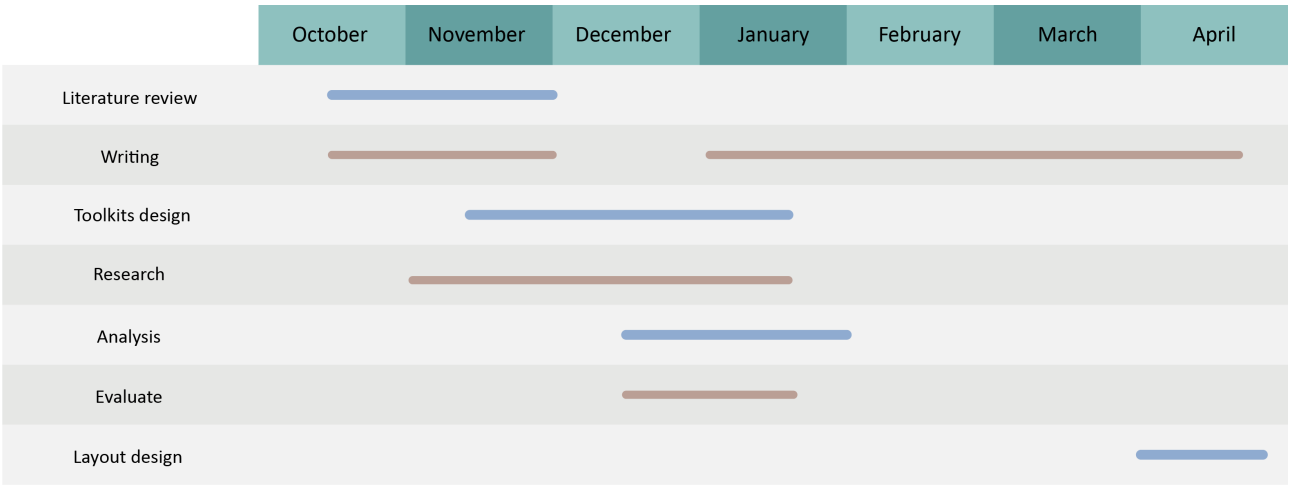


Figure 2. *The project timeline. Beginning with the literature review, the theoretical framework lays the foundation for the design of the toolkit. Then, run the workshops and test the toolkit in China. After that, summarise the outcomes of the workshops and start intensive writing. In total, this thesis is finished in seven months.*

2. Literature review

User engagement is essential in design development. However, in the automotive design field, there is a lack of awareness of engaging users in the early stage of design development (François, et al., 2017). This chapter reviews literature to find answers to the following questions: (1) Why users are needed to be engaged especially in the automotive design project; (2) What kind of tools and activities will be suitable for engaging users in co-design. The structure of the thesis is as follows. Firstly, it explains why users are needed to be engaged in the design and summarizes the benefits of engaging users, especially in automotive design. Secondly, it clarifies co-design as an efficient method to engage users, while it emphasizes design games as an approach applying in co-design activities. Lastly, it introduces and analyses toolkits as an approach to apply in co-design activities.

2.1 User engagement

User engagement is significant in design. Studies discuss that engaging users in the early stage of design are beneficial for collecting user data and understanding their expectations (Sanders, EB-N, 2000; Mustak, et al., 2013; Laage-Hellman, et al., 2014; Yaman, et al. 2016). A recent study points out that customer engagement is an approach to better understand customers' needs that provides opportunities to improve the product (Laage-Hellman, et al., 2014; Yaman, et al., 2016). To discover the potential opportunities, user-centred design is considered as an efficient approach to explore the needs and inspiration of people (Sanders, EB-N, 2000).

The outcomes of user engagement benefit both sellers and customers. In a comprehensive study conducted by Mustak, et al. (2013), on the one hand, three aspects of positive value outcome are summarized from the seller's perspective: economic value, relationship value, and innovation value. In this study, Mustak, et al. (2013) gives detailed explanations of these three aspects: firstly, in terms of economic, by involving customers in productive tasks, the company can increase productivity as well as decrease cost; secondly, to establish a better seller-customer relationship, customer participation improves loyalty and promotes customer satisfaction; thirdly, customer participation accelerates innovation and development.

On the other hand, regarding the customers' position, Mustak, et al. (2013) conclude that customer participation is beneficial for fulfilling expectation, enhancing control and ability, and promoting perceptions of the quality of offerings.

However, Lee.J, et al. (2011) emphasize that, in the company project, it is complicated to make the decision of selecting the participants in the research or design phase.

In general, the above studies provide evidence that user engagement plays a significant role in discovering design opportunities and directly getting inspiration from end-users. The following sections mainly focus on discussing the current situation of involving users in automotive design.

2.2 User engagement in automotive design

The following sections give an overview of the benefits of engaging users, particularly in the automotive design field. In the automotive design process, it is generally accepted that it is beneficial for involving users in the development process (Bekker and Long, 2000; Rogers, Sharp and Preece, 2011). However, at present, automotive design is mainly technology-oriented; users are only involved in the concept assessment and usability tests (François, et al., 2017). The result of conventional market research methods lack deeper user needs; however, companies need new approaches to collect user needs and respond to their expectations (Von Hippel, 2001). As mentioned earlier, user engagement is one way to promote design in the early stage.

Especially in the automotive field, in a recent publication, Francois, et al. (2017) highlights four benefits of involving users in the early stage of automotive design, including economic benefits, getting inspiration from drivers, better meeting market expectations, promoting brand image and improving cognitive ergonomic quality. Francois, et al. (2017) further explain these benefits as follows. Firstly, it brings economic benefits that the company can reduce iteration cost in the later development stage. Secondly, because drivers have professional knowledge in the automotive field, and designers can get access to better understand drivers' needs and insights by involving them in the early stage. Hence automotive design can better meet market expectations. Thirdly, from the marketing and brand image perspective, more involvement in decision-making could bring benefits. Lastly, according to a large number of studies on participatory design, Francois et al. claim

that involving users might improve cognitive ergonomic quality, which includes usability, acceptance and reducing distraction in the automotive field.

Firstly, in terms of usability, Francois, et al. (2017) prove that using drivers' mental models as resources could better improve efficiency, learnability, memorability, and decrease cognitive resources. If the interface does not match with the drivers' mental model, it will cause misunderstanding and misoperation (Maltz and Shinar, 2007; Francois, et al., 2017). Secondly, in terms of acceptance, it is personally related to drivers' experiences, expectations, mindset (Schade and Baum, 2007; Francois, et al., 2017). Therefore, involving drivers in concept design could allow designers to prioritize the subjective factors of the users. Thirdly, in terms of reducing distraction, Francois, et al. (2017) propose that considering drivers' needs and layout preference could reduce distraction and improve visual search efficiency.

However, Francois, et al. (2017) criticize that there are risks in involving users in automotive design. The gap between designers and users cannot be ignored. They claim that drivers are not professional designers and lack of knowledge in fields, such as technical possibilities, engineering, and brand image. In other words, drivers could immerse in one interaction element rather than have a comprehensive vision.

These studies indicate that especially in the automotive field, it is also essential to respect the opinions of people who are influenced by design. It is increasingly becoming a trend that users are given access to freely ideate and design, instead of the company choosing the potential design opportunities from the list of the market research results. Therefore, companies need new approaches to collect user needs and respond to their expectations. In this thesis, co-design will be discussed as an efficient and practical approach to solve these problems.

2.3 Co-design and co-design methods

2.3.1 Co-design

Building on user-centred design, co-design is frequently applied in user engagement (Mattelmäki and Visser, 2011). Over the past two decades, researchers proposed different perspectives of co-design. In 1999, Elizabeth B.-N. Sanders and Uday Dandavate (1999) established a basic definition that co-design is *"exchange between people who experience products, interfaces, systems and spaces and people who design for experiencing"*. Years later, Brandt (2006) pointed out the relationship

between collaborative creation and co-design, describing that co-design is one way to facilitate creative and generative collaboration. Mattelmäki and Visser (2011) summarised Rizzo's (2011) views of co-design, which is *“a set of creative techniques whose aim is to inspire the design process”*. In a recent publication, Kankainen, et al. (2012) stated a more specific and practical principle of co-design that it is referred to *"a particular gathering where at least two persons are at one moment bound regarding place and time"*.

Based on a considerable amount of literature, Mattelmäki and Visser (2011) summarized four directions for co-design sessions: (1)Users will not be ignored and their voices are concerned; (2) Tools can encourage users to interpret, share their experiences and innovate; (3) Designers also participate in the collaborative process, rather than only take the role of the facilitator; (4) To achieve a successful collaborative process, it is indispensable to invite various stakeholders. Instead of discussing these four directions, this thesis will focus on the design of toolkits which is more related to the purpose of the topic.

In all the studies reviewed here, co-design is recognized as a practical approach that users and designers work together to map out previous experiences, assume expectations and generate ideas. The outcomes of co-design events are a co-constructed context, people’s experiences, potential design and wishes, rather than final solutions (Vaajakallio and Mattelmäki, 2014).

2.3.2 Design games

In co-design, there are several methods to involve users and get inspiration from them. In a recent publication, Vaajakallio and Mattelmäki (2014) define that design games are frameworks that increasingly serve as a tool used in co-design, and it is beneficial for involving users and other stakeholders in the early stage of design processes. They claim that the goal of design games is not about polished design solutions but aiming at laying the foundation for design concepts by combining shared user insights and participants’ own experience.

Especially for the users and stakeholders, the two purposes of design games are: 1) to provide practical tools for narrowing down the gap between users and designers (Vaajakallio and Mattelmäki, 2014). 2) to involve various stakeholders in a section to share, discuss, and produce a common understanding of the usage situation and technology in the early stage of design (Brandt and Messeter, 2004; Johansson, 2005;

Vaajakallio and Mattelmäki, 2014).

Vaajakallio and Mattelmäki (2014) summarised that Brant (2006) mapped out four duties of design games related to co-design:
1) games to conduct design
2) games to communicate design ideas
3) games to get insights of the context and current situation through discussion and workflow orientation
4) games to depict scenarios that reveals use situations

However, design games typically include more than the four duties that Brandt mentions. Vaajakallio and Mattelmäki (2014) found out that the other four functions of design games instead of distinguishing various design games:
1) building a shared design language
2) improving an innovative mindset
3) assisting players in assuming and depict the future
4) determining the roles of participants in the interaction

Also, Brandt(2006) introduces two types of design games: Work-flow oriented design games and Scenario oriented design games. As she describes, work-flow oriented design games. Besides, Brandt (2006) indicates two main characteristics of design games. Firstly, it focuses on three areas of designing - staging, evoking and enacting; while the second is the co-create design work. This working procedure is similar to the “path of expression” which can be applied as a framework to recall memories, interpret experiences and future visions (Sanders and Stappers, 2012). The following sections list several examples of design games that are applied in co-design activities.

Firstly, Future Workshops is a co-design activity that has three parts (Jungk and Müllert, 1987; Brandt, 2006). In the first part, the participants criticize the current situation, and the results are categorized into different areas. In the second part, the participants create ideas to slove the problems defined in the first step. During the last step, the participants return to the present, define barriers, plan activities, and estimate the resources needed to achieve their vision. In all these steps, the participants are asked to write down their thoughts to guarantee that everyone can track the process.

Secondly, Storytelling Group is a co-design activity that combines focus group discussions and collaborative scenario building. Kankainen, et al. (2012) state that this method aims to gather stakeholders and build a shared platform for the participants with diverse backgrounds and interests. According to research, focus

group discussion is appropriate for understanding people's motivation, attitudes, opinions, and first impressions (Kuniavsky, 2003; Kankainen, et al. 2012). It inspires the participants to shape a fictional character and the customer journey by telling their own experiences that stimulate them to envision the future without the restriction of current technology and practices (Kankainen, et al. 2012). Kankainen, et al. (2012) point out that in the storytelling group, the fictional customer journey is created based on the real-life stories that encourage the participants to come up with new ideas. The question is whether the fictive scenario building is reliable. Elizabeth B.-N. Sanders and Uday Dandavate (1999) propose that design is curious about specific, observation, implication and subconscious. Kankainen, et al. (2012) assume that specific knowledge refers to real-life stories, while the fictive story creation is benefical to exploring implication, subconscious, feelings and dreams. The study published by Triantafyllakos, et al. (2010) proves that the fictional characters are useful in co-design approaches.

Thirdly, Design: Lab is a collaborative space that engages users and other stakeholders in co-design activities, using data from field research to form artefacts which bridge the lives and experience among stakeholders (Brandt, 2006). It is applied in the middle phase of the design process, and the scope of dialogue-labs includes ideation, concepts, and prototype (Lucero and Vaajakallio, 2009). The dialogue-labs method improves both the efficiency and effectiveness of the co-design activities by applying appropriate materials and tasks in a limited time frame (Lucero, et al., 2012).

Besides, another user game is the Landscape Game that creates a context for the participants. The game materials are the pictures from the physical surroundings or various elements from everyday life (Brandt, 2006). Furthermore, Halskov and Dalsgard (2006) introduce the Inspiration Card Workshop as a cooperative approach applying in the early stages of the design process. It assists in narrowing down the potential design opportunities, with the help of Technology and domain Cards.

Moreover, Kimberly (2018) lists a series of Atomic's Design Thinking Toolkits activities in her study. In these activities, " I like, I wish, what if" aims at quickly solicit feedback. The required time is suggested around 15 - 30 minutes depending on group size. This activity assists in gaining positive, constructive criticism, which leads to a more in-depth exploration of ideas. Negativity restrains creation and forms an isolated space. Kimberly suggests that every participant fills two to five post-its in 10 minutes, then everyone has the chance to express their ideas and discuss their feedback without any interruption. In the study, Kimberly suggests that the facilitator is responsible for encouraging the participants by saying "Yes, and..." rather than,

" Yes, but..." and these details may lead to another "a-ha!" moment in the team discussion.

Another similar activity called "How might we" is produced by IDEO.org (2016). It also worked as a method to frame challenges and stimulate innovation. The "How might we" question assists participants to turn challenges into design opportunities. It does not propose a specific solution but provides a framework for potential innovation. Start by observing the vision description, then try to reword them as questions beginning with "How might we". Think of the questions and broaden it. The questions might generate plenty of answers and will become the starting point of brainstorms. A good "How might we" process not only allows exploration of wild ideas but also narrows down the potential design frame.

In general, these activities are not strenuous for participants to accept. Although participants might lack design knowledge, they could carry out these design activities smoothly and feel engaged in the creation session. Even though the participants have different backgrounds, different interests, and different experiences; these activities serve as the starting point for the participants to share their thoughts and express themselves. Therefore, in design games, everyone shares the same platform and have equal opportunities to participate. The following sections introduce toolkits as a method applied in design games, to efficiently understand user experiences and obtain inspiration from them.

2.3.3 Design toolkits

In co-design activities, it is crucial to choose appropriate methods for different purposes. The methods will produce distinct effects for various tasks. On the one hand, Johansson (2005) emphasizes that professional designers are able to use a pen and a piece of paper to sketch their ideas; however, other stakeholders may need more concrete materials to express themselves. On the other hand, social desirability bias is pointed out by Scariot, Heemann, and Padovani (2012). Henry Ford's quote reflects this point: *“If I had asked people what they wanted, they would have said faster horses”* (Chandler and Van Slee, 2013).

Since users are not specialists in design, tangible materials and engaging activities are the keys to a successful co-design process. Vaajakallio and Mattelmäki (2014) claim that people will be innovative and motivated in co-design activities if designers are able to provide appropriate settings and tools. In an analysis of user toolkits for innovation, Hippel (2001) proposes two main actions for the manufactures to solve

the problem: (1) divide the development tasks into few assignments; (2) prepare design toolkits for users. As Hippel (2001) mentioned, the element of toolkits should be precisely designed based on the types of end-users; hence the users can efficiently complete the tasks.

When involving participants with different backgrounds and interests, building a common language is essential to help the participants to share their experiences and break the boundary (Brandt, 2006). In these design games, the materials and rules assist in building the common language between each participant (Brandt, 2006). Sanders and Stappers (2014) present that generative toolkits are access to transfer design language to non-designers. In the study conducted by Sanders (2000), the components of generative tools are visual and verbal that people can depict their ideas, feelings, and thoughts, while the outcome may be presented by a variety of ways, such as image collages, maps, and stories. According to the preschoolers' case study presented by Sanders (2000), since the verbal skills of preschoolers are insufficient, the efficient way to obtain useful results is selecting, pointing, drawing, colouring and/or constructing. The exclusive rule Sanders adopted in the participatory session is *"Use these components to express how you feel about the experience of xxxxx. You can do whatever you want, as long as it makes sense to you."*

The study presented by Halskov and Dalsgard (2006) indicates that the design materials include video, paper documents, mock-ups, prototypes, and posters, for example, text and images are printed on paper documents. Instead of playing videos, the pictures from video clips are combined with single words, which form the conceptual framework for the design activities. Moreover, Brand and Messerter (2004) observe that tangible design game materials support various stakeholders to make design concepts, and these design artefacts play an essential role to facilitate communication in design activities.

In the co-design activities, cards are created by designers and serve as tangible containers of ideas. During the User game, the "Moment-cards" are selected from each video-snippet and are used as tangible tools for the participants to create a common language, while the "Sign-cards" assist the participants in creating a conceptual framework in order to interpret the stories (Brandt, 2006). Design cards are a low-tech and feasible method, which can introduce information and inspiration into the design process and has the characteristics of distinguishing it from other media (Lucero, et al. 2016). In the study of design cards, the researcher points out that participating in collaborative design through cards can reduce the difficulty, and design cards can make creative activities more acceptable (Lucero, et al. 2016).

For example, the PLEX Cards are used to mark conceptions (Lucero and Arrasvuori, 2010), while the Inspiration Cards are described as a carrier to conceive inspiration (Biskjaer, Dalsgaard and Halskov, 2010).

In the study of Inspiration Cards Workshops, the Inspiration Cards can serve as a principle for gathering and a consistent source of inspiration, as an approach to outline various concepts, as a way to facilitate the communication between designers and domain experts, and more (Halskov and Dalsgård, 2006). The researchers emphasize that the Inspiration Cards are always used in the early steps of the design process, before prototyping and mock-up; by using these cards, the designers and experts can narrow down future design opportunities.

The study of the Inspiration Cards presents the content of the cards, which is divided into Technology Cards and Domain Cards (Halskov and Dalsgård, 2006). Each Technology Cards presents one specific technology or specific application of technology. With a short description of the technology, the cards assist the participants in gaining knowledge of the technology and applying the technology into a specific design project. Additionally, Domain cards represent the information that may be related to conditions, people, settings, topics in the domain.

In an evaluation of card-based tools, Clatworthy (2011) concludes three requirements of card-based tools applying in innovation development: cross-disciplinary team building, analysis and depicting, and idea-generating. According to the five workshops in 2010, Clatworthy reported the evaluation of car-based tools. One participant commented that *"the use of visual tools simplified the process and created a common understanding in the group"*. In contrast, others considered the tools as an efficient method to map the holistic context. Although it concerns that the tools would limit the invention, several participants found that tangible tools are effective in broadening the scope of the context.

By iterating the card-based tools, Clatworthy (2011) notices that in order to assist participants in understanding the project contexts, the card-based tools should be definitive rather than abstract. It means that physical form, size, and images of the cards can influence the cognitive process and the quality of the outcomes of the workshop. He also suggests that physical cards provide more benefits than the digital version.

Except for the toolkits, the following paragraphs discuss the elements which have a significant impact on the design games, focusing on personas, rules, physical playground, and facilitator.

Personas

In the study (Cooper, 1999; Brandt, 2006), a persona serves as an element to describe and discuss with others. The description of the persona includes work-flow, goal, context and attitudes of the persona (Brandt, 2006). The study reveals how to describe the persona in the further design work, and as the suggestion, it is divided into three steps: persona, needs & situations, scenario (Nielsen, 2004; Brandt, 2006). Vaajakallio and Mattelmäki (2014) confirm that participants switch roles to gain new perceptions and empathize with others' experience in design games. They point out that although the actions and stories are fictional, the reactions, opinions, and emotions of performances and the audience are real. For instance, in the case study of Character Game, the service providers were asked to think from the user's view, which reminds them of their memories and experiences (Vaajakallio and Mattelmäki, 2014).

Rules

Vaajakallio and Mattelmäki (2014) indicate that tension is a core quality for improving motivation. Besides, Brandt (2006) notices that vague rules trigger the players and encourage the participants to define a worthwhile target. The printed out rules bridge the gap between the actual tasks and the play areas (Vaajakallio and Mattelmäki, 2014). Moreover, the rules create a positive tension among the participants when they notice the next movements of the design game (Vaajakallio and Mattelmäki, 2014).

Besides, the process of design games is designed based on specific tools. For example, the Inspiration Cards consist of Domain Cards and Technology Cards (Halskov and Dalsgård, 2006). As they described, during the Inspiration Card Workshops, the participants can begin with choosing a topic or situation in the area they want to support, or make a transformation, and then choose technology cards to achieve the goal. As a choice, the order of selecting the cards can be changed. Except for these two types of inspiration cards, they also recommend providing blank cards that the participants can create by themselves.

Physical playground

Agger Eriksen (2012) points out that the physical playground will influence the overall performance. Establishing an inspiring physical space is an essential aspect to stimulate participants to express their ideas, for example, a large room with well-arranged furniture and an open window, which provides an excellent view (Lucero and Vaajakallio, 2009).

Facilitator

Furthermore, the key to a successful workshop is the facilitator's skill in encouraging the participants and keep them concentrated on the tasks (Lucero, Vaajakallio and Dalsgaard, 2012). In the workshop, the facilitator plays the role of guider of the discussion and ensures every participant is involved in the discussion (Lucero, et al. 2016). The researchers suggest that during the workshop process, the facilitator may also concentrate on the types of concepts and provide suggestions if participants struggle with the toolkits.

Together, these studies indicate that toolkits are applied in co-design activities to provide non-designers design competence. The element of toolkits needs to be adapted to different usage scenarios. In co-design activities, in addition to providing design competence to users, toolkits encourage users to express themselves. It is beneficial for users to recall their previous experiences and generate ideas.

Conclusion

Since users are influenced by design, they need to be heard in design projects. Especially in automotive design fields, user engagement is beneficial for improving usability, acceptance, and reducing distraction. However, users are not professional designers; hence they demand tangible tools to recall the experience, map context, and generate ideas. As mentioned in the literature above, serving as an approach in co-design activities, design games should be designed based on different purposes. These studies clarify that design toolkits are able to assist the non-designers and facilitate the design moves in design games. These studies will guide the further design process.

3. Desktop research

This chapter begins by discussing the current situation, the future trend of automotive development, and specific examples based on secondary research. Then, potential customers reveal the future market and potential design opportunities. This chapter concludes by carrying out the benefits of nuances emotion. The desktop research informs the design of the toolkit.

3.1 The future trend of automotive development

Currently, there are still a series of problems in current car usage scenarios. According to the report published by The Nielsen Company (US) (2018), family trips (98%) and commuting (93%) are the primary usage scenario in daily life. At present, drivers are still struggling with traffic and parking problems which cause poor driving experience and frequently happen. The report shows that customers hope to improve the situation by self-driving, which relieves tiredness and accidents. Also, the report states that currently, the assistance systems like Adaptive Cruise Control and Advanced Driver Assistance Systems remain problems, for instance, they are not workable in low-speed scenarios.

The automotive industry forum published the report of Top Ten Development Trends of Future Automotives (Auto. Sohu, 2018). The report indicates that autopilot will quickly become a reality; at the same time, self-driving shared cars will provide services for private and business consumers. Besides, sharing-car services will continue to proliferate, by 2025, a large number of car sales in major automotive markets will be used in the field of new travel services. Since the cars are idle 95% of the time, the sharing business provides opportunities to effectively match cars to those who want to use them (Goldman Sachs, 2015). Therefore, a new automotive ecosystem is gradually taking shape. In this ecosystem, customers will use mobile phones to share cars with others or hail rides (Boyden Web Site, n.d.). In the era of the gradual rise of ride-hailing service, the self-driving Robo-taxis is regarded as the next trend to improve the travelling experience and the quality of life (Muller, 2018).

Besides, the "2018 Autonomous Driving Syndicated Report" published by The

Nielsen Company (US) (2018) demonstrates that 61% of owners are convinced of that self-driving cars could free their hands, and 57% of owners think it will improve the driving experience and guarantee the safety. The self-driving cars are able to reduce road accidents, clear up traffic, and provide mobility to more people (Goldman Sachs, 2015).

The research presented by Bosch (2017) predicts that in a few years, self-driving cars will be widely accepted and become common in daily life. The main expectation of the responders is that self-driving means more comfortable and less driving stress. In the future, free-hands driving is primarily considered suitable for long-distance travel (67%) and leisure travel (61%). Most of the responders suppose that self-driving cars will bring benefits to finding parking spaces as well as improve convenience and safety. The research also points out that people mostly expect self-driving can improve parking experience (65%), followed by searching for parking in the city centre (60%) and free navigation of traffic jams (59%).

However, the report from The Nielsen Company (US) (2018) reveals that 60% of owners doubt that the self-driving car will be dangerous. especially for pedestrians and cyclists. Therefore, safety becomes a vital issue of self-driving (64%), followed by comfort (35%), brand (34%), and driving control (33%).

Furthermore, the research released by Goldman Sachs (2015) indicates that in 2025, drivers will look at cars in different ways, using them as a space for living, working, and entertainment. The potential design opportunities will arise from future demand and emerging markets. In other words, the potential users and new scenarios of driving will lead new design trends for automakers. For instance, the research reveals that more than 50% of the users would like to enjoy the music, make a phone call, watch videos or surf the Internet while travelling by car.

The report from Bosch (2017) demonstrates that instead of concentrating behind the wheel, the majority of drivers would like to relax and enjoy the scenery during the journey. In autonomous driving mode, 63% of responders prefer having leisure time and consider that talking with other passengers is also essential. The self-driving car is attractive for customers because it provides more options for the journey. In particular, the male responders regard advanced technology as an essential selling point, and they will see self-driving as a purchase motivation. In general, younger drivers are more interested in self-driving cars.

Olive Zhang, vice president of Nielsen China, emphasizes that although problems remain in the development, especially safety issues, a large number of consumers

are expecting self-driving to become a reality in daily life (The Nielsen Company (US), 2018). She believes that self-driving vehicles can meet more needs of users and improve user experiences.

Thus, with the development of technology, the future car usage scenarios will be different from the current situation. The report from The Nielsen Company (US) (2018) presents that self-driving will meet more personal demands in the future. The scenario will be going out with friends (46%), commuting (43%) and self-driving travel (short distance: 42%; long-distance: 40%). If the users do not need to drive, they prefer to take a rest (76%), enjoy entertainment (54%), browse the Internet (44%) or work (36%). In particular, the report notes that female car owners would like to socialize (51%), work (40%) or shop online if they can have other activities in the car instead of driving.

3.2. Examples of future car usage scenarios

The following examples depict specific future scenarios. Firstly, different to the existing concept of autonomous vehicles, Mercedes-Benz develops VisionURBANETIC which satisfies the needs of cities, businesses, urban residents and travellers by eliminating the separation between the movement of people and transportation of goods (Mercedes-Benz AG, n.d.). This concept not only achieves sustainable and efficient movement of people and goods but also relieves traffic flow and improves the quality of urban living. As mentioned on the website of Mercedes-Benz, this ride-sharing car can carry people and goods separately according to different needs (Figure 3). During rush hours, it is mainly used to transport people with the people-mover modules (Figure 4); during other times, it is mainly used to transport goods by carrying the cargo modules (Figure 5). When it carries passengers, it can create spaces for up to twelve people. When it carries goods, the body of the vehicle will be transformed into shipping mode, which maximizes the use of space in the car to achieve efficient transportation.

Secondly, the Bosch IoT shuttle is a self-driving electric vehicle that is bright, airy and comfortable (Robert Bosch GmbH, n.d.). Bosch describes that the aim of the Bosch IoT shuttle provides a relaxing travel experience for people travelling alone or travelling with others. It equips with plenty of infotainment options for passengers to relax and have fun during travelling, which simplifies the user's daily life and provide passengers with more entertainment possibilities (Figure 6). For example, when getting into the shuttle, it will welcome passengers and display all the information

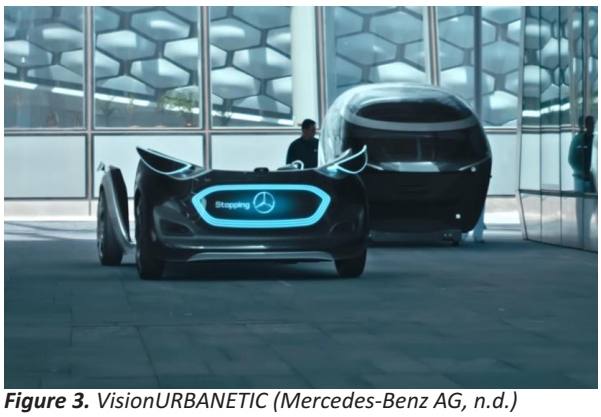


Figure 3. *VisionURBANETIC (Mercedes-Benz AG, n.d.)*

Figure 4. *VisionURBANETIC (Mercedes-Benz AG, n.d.)*

Figure 5. *VisionURBANETIC (Mercedes-Benz AG, n.d.)*

Figure 6. *Bosch IoT shuttle (Robert Bosch GmbH, n.d.)*

related to the user. Besides, although the passenger changes the destination during the journey, the shuttle will automatically assist the passenger in arranging the best route based on the passenger's personal information which means that the passengers do not need to do anything. Moreover, when the passenger takes the shuttle with colleagues, they can use the shuttle as a working space to better use the journey time, for instance, the big screen in the shuttle can be used to display the working documents.

Another user-centred concept called Sedric is created by Volkswagen (Volkswagen AG, 2018). When pushing the button, it will automatically come to the user. Having the ability to make the decision, Sedric is an excellent choice for car-sharing and personal use. For instance, it can drive the children to school; then take their parents to their workplace; after that it will pick up tourists from the station; lastly, it will park by itself. Through voice control or the mobile application, all the functions can be implemented quickly.

In addition, May Mobility is also developing self-driving shuttle and testing in Detroit. The core idea of May Mobility is improving the travelling experience and developing unique services to make the traffic safer and more personal (Muller, 2018). The article points out that testing in the Motor City, the shuttle is trying to solve the "last mile" problem.

3.3 Potential customers

In the 2016 Global and China Vehicle Consumption trend white paper (The Nielsen Company (US), 2016), Nielsen revealed that significant changes had taken place in the behaviours of worldwide consumers, and the current consumer groups consist of the middle class, the young generation, mobile, and connected consumers.

The research from The Nielsen Company (US) (2017) points out that improving the travel convenience (62%) and quality of life (49%) are the primary motivation for the new urban immigrants to purchase cars, while non-immigrants prefer to enjoy the driving experience and improve their social status. To improve travel convenience, the high-income group would like to have a self-driving tour. They do not only focus on prices but also focus on the operation, dynamic, space and comfort. Customers expect that they can enjoy the driving experience while their family can enjoy the travelling experience.

Moreover, according to data from The Nielsen Company (US) (2018), the majority of consumers who prefer self-driving cars are fascinated with technology (63%). This consumer group has the following things in common: (1) enjoy healthy leisure activities, such as travelling (47%), hiking (35%) and playing ball games (25%). In total, this consumer group spends more than three hours on mobile devices every day.

3.4 Nuances of emotions

Psychological literature shows that the development of emotional granularity brings several benefits; for example, with high emotional granularity, people will feel more flexible and active (Tugade, Fredrickson and Feldman, 2004; Yoon, Desmet and Pohlmeyer, 2013). Emotional granularity reveals the difference in the individual's ability to accurately express and explain the emotional state of himself and others, which refers to different emotional words, not just the general sense of pleasure (Yoon, Desmet and Pohlmeyer, 2013). The study indicates that people with high emotional granularity can precisely express their emotional experience and show their uniqueness by using distinct emotion words, while other people with low emotional granularity rely on the blurred words, such as happy, good or pleasant to convey their emotional experience (Tugade, Fredrickson and Feldman, 2004; Yoon,

Desmet and Pohlmeyer, 2013).

In the study of emotional granularity in design, the researchers indicate two advantages of having high emotional granularity (Yoon, Desmet and Pohlmeyer, 2013). Firstly, it can help the designers to understand users' complicated emotional responses in the early design stage. Secondly, it guides the designers to set subtle design goals based on the design emotion they expected. Through the workshop conducted by Yoon, et al. (2013), the participants indicate that high emotional granularity can be applied as an approach for participating in design activities with different stakeholders effectively. They also suggest that high emotional granularity should be designed related to specific design activities.

In the study of nuances of emotions in the product development, the researchers proposed seven benefits of using positive emotion granularity (PEG) in the product development process (Yoon, Pohlmeyer and Desmet, 2014). The following section briefly list the benefits of PEG revealed by the study.

(1) During the product development stage, PEG can help the designers deeply understand users' emotions and accurately explain end-users' responses to the product or situation.
(2) Specifying user emotions in detail would help designers to define design intention and potential design opportunities for a new product. Manwhile, it is necessary for designers to have a method for showing how positive emotions influence the way people interact with products in different ways.
(3) In the strategy stage, this approach is able to guide the client or manager empathize with end-users and rethink the project goal; therefore, the company would realize the importance of emotions in product development.
(4) PEG can help participants build the same cognition to make communication more effective.
(5) As the starting points of creation, PEG can stimulate design creativity and guide the participants to open their minds.
(6) In the stage of market introduction, marketers can emphasize the same emotional experience to avoid the emotional deviation in marketing communication.
(7) The product managers noticed that understanding the nuances of positive emotions help the product development team build the appropriate positive emotions.

Furthermore, through the interviews with 25 design professionals, Yoon, Pohlmeyer and Desmet (2014) realize that negative emotions also influence a specific context and user experiences. The results of the interviews with designers and user

researchers show that, as same as positive emotions, nuances of negative emotions assist the users in expressing their demands and expectations. Hence negative emotional granularity might also play an essential role in design.

In summary, the several research in this chapter clarifies that with the development of technology, the automotive industry is transforming. Vehicles will shift from transportation to living space, and new products and services will improve travelling quality. Also, the demands of potential customers will conduct future automotive design. In chapter 5, the selections of car usage scenarios are based on desktop research. Besides, the above research points out the benefits of nuances of emotion. Therefore, in the design stage, both positive and negative emotions will be used as a trigger for the participants to recall their experiences, map the context, and generate ideas.

4. Experts interviews

Before design, four expert interviews are conducted to understand the experts' attitudes of future automotive development and user engagement in design. These four experts are from the internal company. In the automotive field, the four experts are respectively engaged in market research, UX design, UI design, and technology. The interviews are conducted through WeChat. Below is a list of the interviewees.

(1) The technical consultant, Liu. He has been working in the automotive industry for 30 years and has an in-depth understanding of the automotive industry.
(2) The market researcher, Liu. She is majored in market management and has been working as a market researcher for three years.
(3) The UX designer, Tan. She has three-year working experiences of UX design in the automotive industry.
(4) The UI designer, Zhang. He is majored in visual design and has been working as a UI designer for one year.

This chapter separately states experts' views on the future trend of automotive and user engagement in design. In the interviews, I asked the experts several questions to get insights. For different experts, the questions are slightly different. Below is the list of the interview questions

Overview questions:
(1) What do you think of the future development trend of automotive, such as the self-driving car, sharing and alternative fuel vehicle?
(2) How does the company do preliminary research currently?
(3) What do you think of engaging users in the early stage of design?

Questions for the technical consultant:
(4) What do you think of the safety problem of the self-driving car?
(5) What scenarios do you think are the future trend of car usage experience.
(6) What do you think of ride-hailing services and sharing car services?

Questions for the market researcher:
(7) What is the format of the focus group?
(8) What kind of topics will be discussed in the focus group?
(9) Why the user group and the expert group are separated?

(10) What are the differences between the user group and the expert group?
(11) What standard will be used to select the users and experts?

Questions for the UX designer and UI designer:
(12) What methods are used to understand users' needs and expectation?
(13) What is the primary responsibility of the UX designer?
(14) Do you collaborate with other market researchers?
(15) Are the users engaged in the early stage of experience design?

4.1 Views on the future trend of automotive

From the experts' point of view, the vehicle will become a more convenient means of transportation and living space in the future. The technical expert points out that the self-driving car is a future development direction. One of the main scenarios of the self-driving car will start from the highway since it is safe that only vehicles can drive on the highway. Besides fixed-lined scenarios there will be another main scenario, for example, the route between the bus station and airport is easy to identify. Additionally, automatic delivery will become a reality and users can remotely control the vehicle. The technical expert is optimistic about self-driving cars and believes that after self-driving cars become widely used, the sharing car will also become popular. Furthermore, the expert points out that autonomous taxis can continue to be used after reaching their destination which can not only solve the problem of shortage of parking spaces but also provide more spaces for other infrastructure in the city. Although the experts highly agree that self-driving cars are a trend, they also admit that the pleasure of driving will undoubtedly remain. Therefore, the traditional car will not disappear.

The technical expert admits that currently self-driving commuting in cities is difficult to achieve since it is hard for the radar to judge obstacles, such as pedestrians and cyclists. With the development of technology, sharing and alternative fuel vehicle are also long-term development directions. However, it takes time to promote fully.

In addition, the market researcher mentions that electric and hybrid cars will be vigorously advertised. However, there are still many problems, such as battery life, safety, and environmental protection. From the experts’ point of view, in China, policy drives the market and markets drive technology. At present, the electric car is highly recommended by the government and the charging infrastructure is improving step by step.

4.2 Opinions of user engagement in the design

The initial research process in the internal company is desktop research; analyze characteristics, consumption trend and define target users. Then the market researchers figure out the demand of consumers by analyzing the investigation. The market researcher points out that they mainly use quantitative research methods and qualitative research methods, such as survey, focus group, observation, and in-context interviews.

The focus groups are divided into user groups and expert groups. The user group recruits target users and potential users. In the user group, the moderator asks the participants the pain points, their daily life and their opinions of car consumption. The participants in the expert group are well-known and influential in the automotive field. In the expert group, the moderator asks more about their opinions of future consumption trends and what do experts think of the users.

After the market research, the UX designers collaborate with market researchers to finish the scenario design, since the market researchers do not have the ability to visualize the demands and they do not have design competence. The UX designer outlines their responsibilities from three aspects. Firstly, she regards their role as the end of research and the starting point of the design. Secondly, the main task of the UX designer is to combine the customers' needs and the HMI system. Lastly, she defines the highlights of the functions.

Furthermore, the UX designer states that they are trying to engage users in several projects. However, at this stage, it is difficult to evaluate the value of engaging users in automotive design. In terms of in-vehicle design, the UX designer believes that engaging users is beneficial for improving the users' experience of using software and hardware. However, the appearance should be designed by professional designers. As the UX designer mentions that, *"Vehicle is a long-term product, the non-designers do not have the ability to lead the aesthetics style."*

However, the UX designer also said, *"the cooperation among UX designers and market researchers is also an attempt in these two years. However, the structure of the company is changing. The company decides it, and I am not sure what will happen in the future."*

5. Design process and proposal

Based on the research from the earlier, this chapter presents the entire design process. This chapter describes the process of each workshop, evaluation of the findings and iteration of the design of the toolkit in detail, followed by the summary of the co-design activity evaluation and outcomes of the co-design activities. In total, the workshops recruit 28 participants, and the toolkit is iterated twice. Afterwards, the outcomes of the co-design activities are not the final solution for the automotive design but list the potential design opportunities in each car usage scenario.

5.1 First Toolkit Design and Workshop

5.1.1 Toolkit Design

The first toolkit includes 16 positive emotional cards, 16 negative emotional cards, 11 user experience cards, 5 persona cards, and an artboard.

Emotional cards

Firstly, the references of the emotional cards are from the Delft Institute of Positive Design. The Delft Institute of Positive Design creates Positive Emotional Granularity Cards which consist of 25 cards. These 25 cards are divided into nine groups, including "empathy, affection, aspiration, enjoyment, optimism, animation, assurance, interest and gratification" (Yoon.J and Jeong.N, 2013).

Additionally, the Delft Institute of Positive Design also discovers the nuances of 36 negative emotions. The 36 negative emotions are divided into 15 groups, including personal provocation, agitation, antipathy, repulsion, unmotivated, misfortune, social hurt, painful desire, self-blame, social failing, concrete threat, ambiguous threat, the uncertainty of action, helplessness and overwhelm (Delft Institute of Positive Design, n.d.).

I analyse these emotions and rearrange them into 16 positive emotions and 16 negative emotions. Size of the card is designed based on the playing cards, which is suitable for grasping with one hand. One card stands for one emotion, with one picture and a brief description (Figures 7-10). To create the positive emotional cards,

positive

JOY

Better than expected

积极情绪

喜悦

比期待的更好

positive

RELAXATION

Relaxed, without stress

积极情绪

宁静

放松的，轻松的

positive

AMUSEMENT

To enjoy a playful state of humor or entertainment

积极情绪

消遣

愉快的，好玩的

positive

ENERGETIC

To enjoy a high-spirited state of being energized or vitalized

积极情绪

精力充沛

有活力的

positive

ENCHANTMENT

To be carried away by something that is experienced as overwhelmingly pleasant

积极情绪

着迷

出神的，被迷住

positive

WORSHIP

To experience an urge to idolize, honor, and be devoted to someone

积极情绪

崇拜

赞不绝口的

positive

HOPE

To experience the belief that something good or wished for can possible happen

积极情绪

希望

期待好事发生

positive

KINDNESS

To experience a tendency to protect or contribute to the well-being of someone

积极情绪

友好

有益的，支持的

Figure 7. *Positive emotion cards. The cards are selected and simplified from the Positive Emotional Granularity Cards designed by Delft Institute of Positive Design.(English - Chinese)*

Figure 8. *Positive emotion cards. The cards are selected and simplified from the Positive Emotional Granularity Cards designed by Delft Institute of Positive Design.(English - Chinese)*

Figure 9. *Negative emotion cards. The concept is based on the Negative emotion typology and the cartoon are designed and sketched by the author.(English - Chinese)*

Figure 10. *Negative emotion cards. The concept is based on the Negative emotion typology and the cartoon are designed and sketched by the author.(English - Chinese)*

I rearranged the Positive Emotional Granularity Cards created by the Delft Institute of Positive Design and simplified the description. Besides, on the Positive Emotional Granularity Cards, there are four cartoons on each card; however, I only chose one from them to make the cards as simple as possible. In order to unite the cards, the negative emotional cards apply the same format of the positive emotional cards. Different from the positive emotional cards, the cartoons on the negative emotional cards are sketched by myself. Because the workshops were held in China, the toolkit is translated into Chinese.

User experience cards

In addition, I designed the user experience cards. User experience scenarios are selected based on the analysis of the internal company, Nielsen's report and Bosch's research. The research of the internal company shows the entire process of users' car usage, which are purchase, preparation, get on and off, using, sharing and reset. The "using" is divided into driving scenarios and daily life scenarios. The driving scenarios include driving, navigation, and parking, while daily life scenarios include entertainment and social. As mentioned in the earlier part, rest, working and enjoy scenery are other scenarios that happen in the current trip. The customers highly expect these scenarios. Especially in the future, self-driving will be widely used in daily life. Therefore, eleven main user experiences are chosen from the entire process of users' car usage. They are ***purchase, get on and off, driving, parking, navigation, entertainment, social, rest, working, enjoy scenery and sharing*** (Figures 11-13).

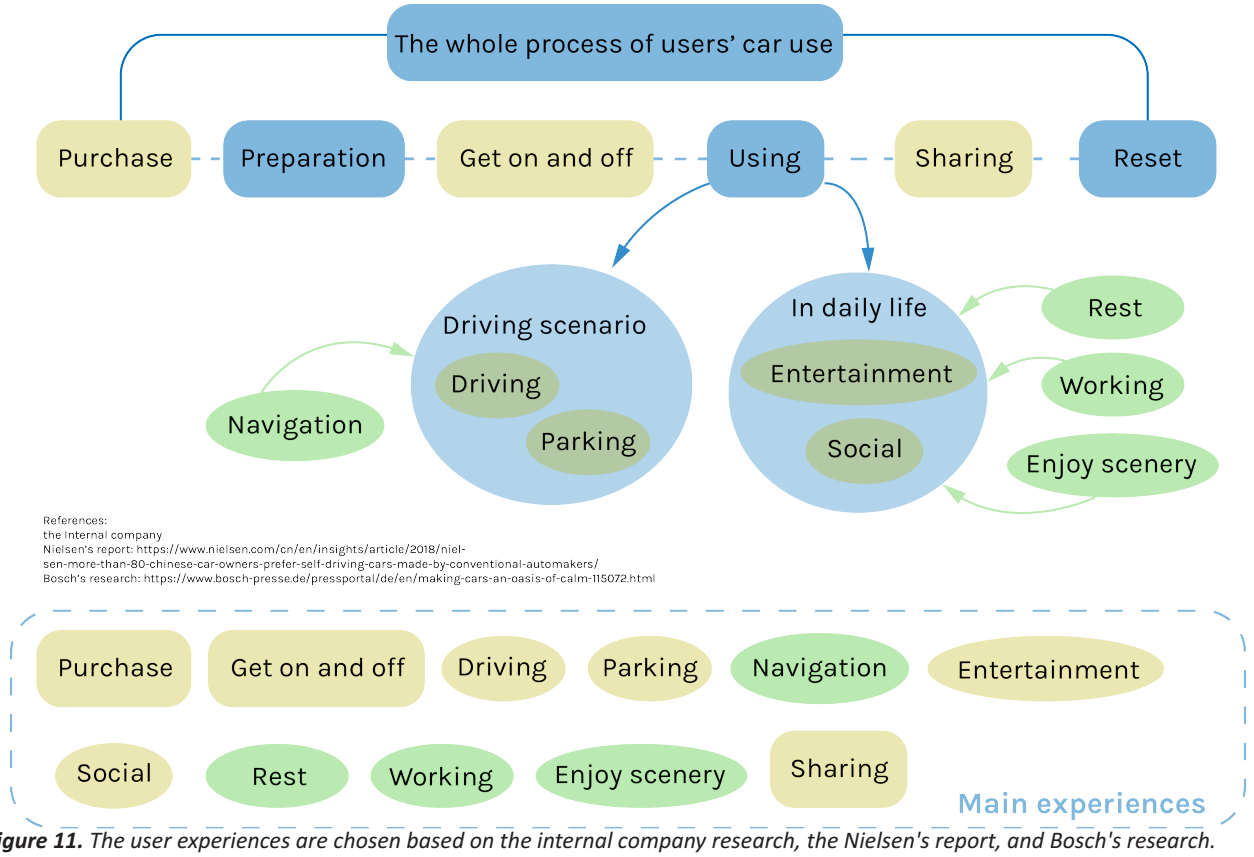


Figure 11. *The user experiences are chosen based on the internal company research, the Nielsen's report, and Bosch's research.*

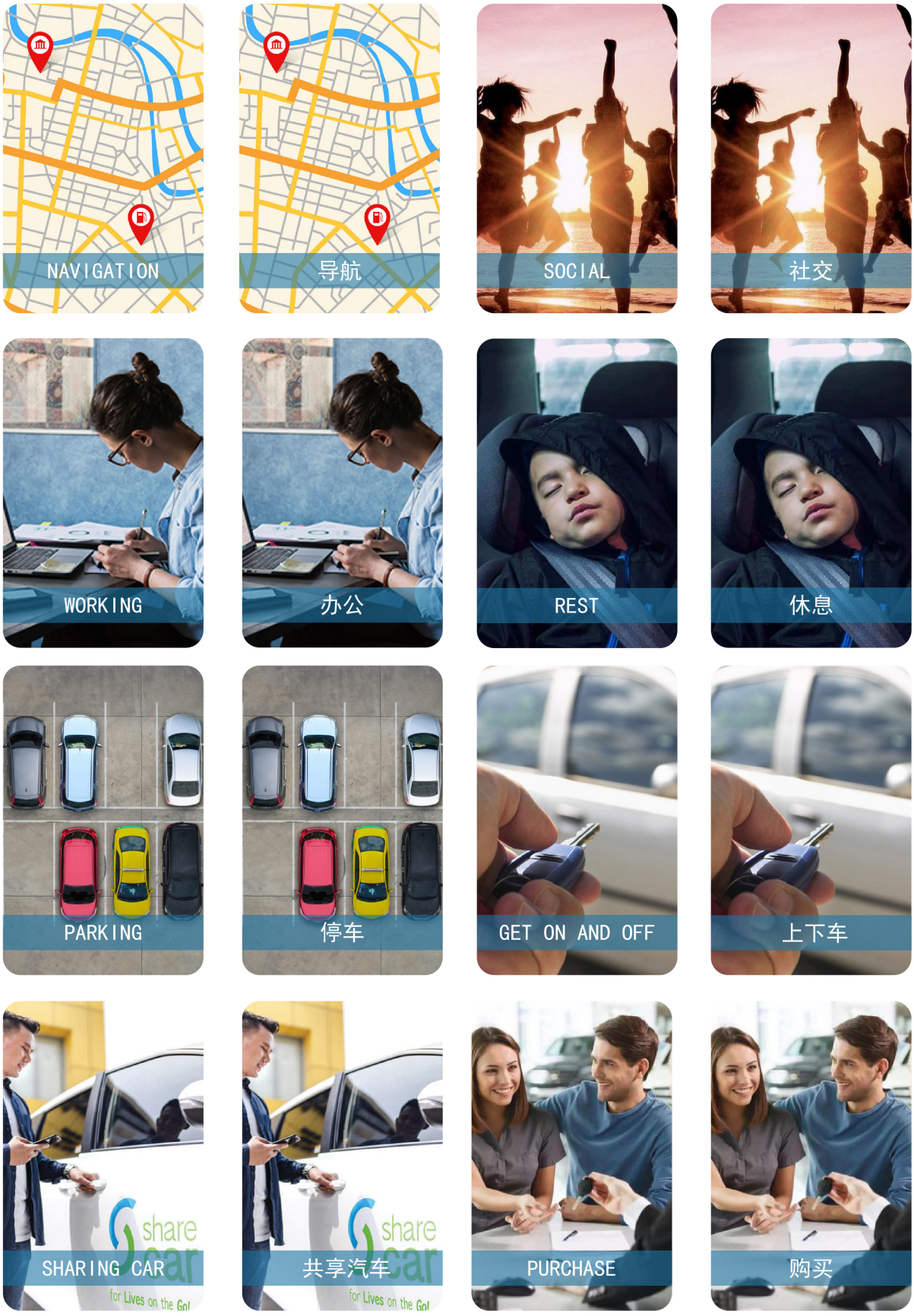


Figure 12. *The user experience cards. (English- Chinese)*

Figure 13. *The user experience cards. (English- Chinese)*

Persona cards

Furthermore, I designed five persona cards. Each card stands for one user persona. Each persona matches several typical scenarios, such as commuting, family trip, and sharing the car. Except for scenarios, each persona has its corresponding characteristics (Figure 14). The five personas are: (1) The young male persona who is addicted to fitness and technology drives to and from work every workday. (2) The young office lady who relies on social media commutes every workday, but in order to save money, the young lady needs to share a car with others. Most of the time, she does not know the other passengers at all. (3) The middle-aged man is an office worker who has many years of driving experience. He drives himself to and from work alone every workday but regularly drives during the rush hour and wastes lots of time on the way. (4) The housewife is another typical persona who regularly drives to market and buy lots of daily necessities, but at the same time, the housewife relies on online shopping. Like other female users, the housewife is fascinated with social media and entertainment. (5) Family is another typical persona that consists of parents and children. Different from other user personas, the family always has a short-distance trip or long-distance journey during the holiday. Therefore, highways and country roads are the main driving scenarios, instead of urban areas.

Figure 14. *The persona cards are only used in the first and the second workshops. Based on the feedback from the participants, the persona cards are removed from the final design toolkit. (English - Chinese)*

Artboard

Artboard shows the whole task process (Figure 15). Firstly, the participant is asked to choose one persona based on the participant's own experiences. Secondly, the participant is asked to think from the perspective of the persona, try to write down the persona's goal and expectation. Thirdly, the participant is asked to choose user experience cards. Then browse the negative emotional cards and positive emotional cards at the same time, think and explain what emotions are generated in these experiences currently. Repeat the tasks four times. After finishing the tasks, the participant is asked to rethink the original goal. At last, the participant is asked to think about which experience produces the most negative emotion, then choose a problem that needs to be solved.

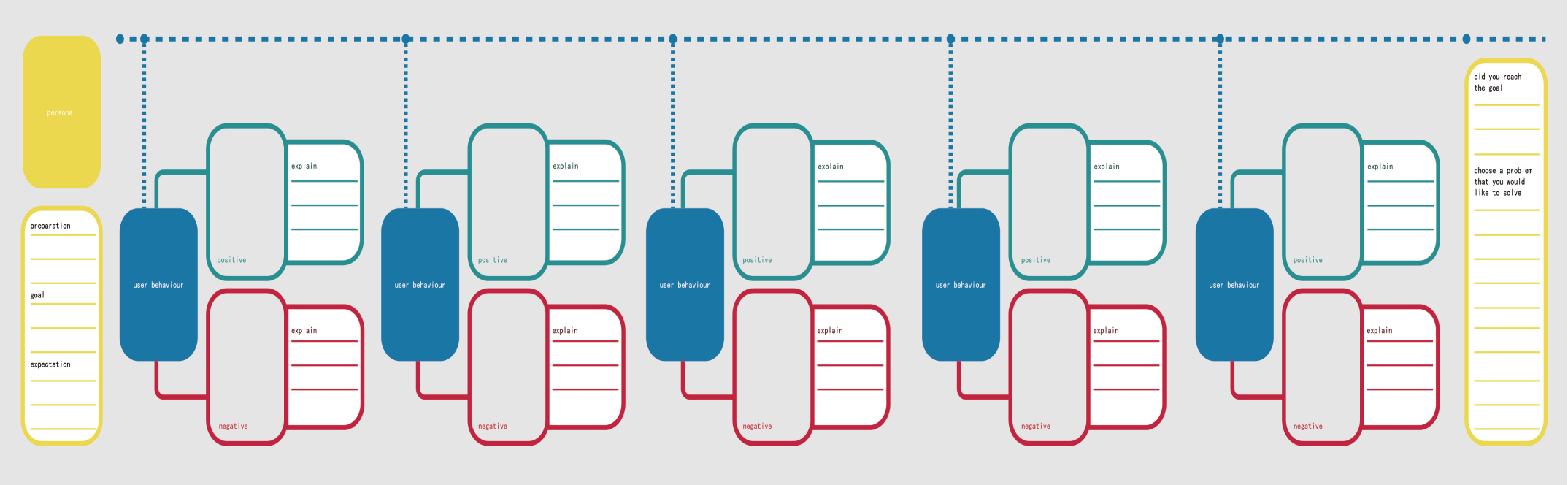


Figure 15. *The initial artboard, which is applied in the first workshop.*

5.1.2 Pilot Test

Participant: 1 (one female)
Scenarios: commuting and family short-distance trips.
Time: 15.12.2019, around 40 minutes.
Place: the participant's private space

Process

The first workshop is a pilot test which aims to test whether the toolkit encourages the participants to recall past experiences and whether the toolkit can dig deeper into the current problems. The first workshop is an individual pilot test which only recruits one participant. The participant is a middle-aged woman who has 15 years of driving experience. The workshop began with a brief introduction. Firstly, I simply introduced the project to the participant. Secondly, I showed the toolkit that would be used in the test to the participant so that the participant would have a basic knowledge about the test. Then the participant completed the task step by step with the help of the facilitator. During the process, when the participant chose the emotion cards, she recalled her previous experience and shared the stories with the facilitator. Instead of choosing one emotion card to match one experience card, the participant thought of every emotion card. If the participant cannot immediately come up with an experience related to that emotion, she would immediately skip it and choose another one.

Findings

Firstly, at the beginning of the pilot test, the participant found that it is overwhelming to select five experience cards and complete the task by herself. I noticed that she felt stressed and quickly lost interest. Therefore, to make the participant feel relaxed, and the workshop run more smoothly, I reduced the tasks from five to three while keeping the other processes unchanged. After changing the tasks from five to three, the participant was more patient and concentrated.

Secondly, in the pilot test, because the task line is horizontal, the participant regarded the task line as the timeline. Under the circumstances, the participant found that it is hard to distinguish the order of each behaviour. The participant was confused when choosing the order of the cards because during a journey, some

of them are continuous, and the others are likely to be repeated. In other words, because many behaviours occur simultaneously or repeatedly, for the participant, it does not make sense to have a "timeline".

Thirdly, while choosing the emotion cards, I realized it is confusing for the participant to choose both negative and positive emotions for one behaviour at the same time. Besides, when looking back on the previous experiences, the participant found that the experiences can trigger more than one emotion, whether it is positive or negative. Although there are 32 emotion cards for the participant to choose in total, the participant did not feel stressed and browsed the cards quickly.

Moreover, I noticed that when the participant began to choose the experience cards, she was confused about relating the experience cards with the persona. In other words, the "goal" and the "expectation" of the persona are too abstract for the participant and make the participant felt confused, as a result, the participant would ignore and skip them. According to the outcomes of the workshops, the "goal" and "expectation" cannot encourage the participant to complete the task; thus, these parts can be removed from the whole task.

In general, the pilot test still focuses on the current situation. Just writing down "goal" and "expectation" is too superficial; the participant does not regard this part as an essential task. However, except for the existing problems, it is also essential to tap more expectations in the subconscious of the participant. Therefore, the toolkit should emphasize the "expectation" in another way and encourage the participant to generate ideas, rather than only recalling past experiences.

5.2 Second Toolkit Design and Workshop

5.2.1 Toolkit Design

According to the feedback from the first workshop, the second version of the toolkit has changed significantly. As mentioned above, the purpose of the workshop is not only to understand the existing problems but also to explore the users' expectations. Therefore, the main updates of the toolkit are the task artboard, the usage of emotion cards and the workshop process.

Firstly, as shown in Figure 16, the "goal" and "expectation" are removed from the artboard. Moreover, the artboard is divided into four parts: persona, current negative emotions, expected positive emotions and brainstorming. Different from the first version, in the second workshop, the positive emotion cards serve as tools to encourage the participants to imagine the future. They are also regarded as the beginning of the design, which assists participants in shifting from problems to ideas. In my opinion, for the participants who do not have design competence, it is indispensable to facilitate them to understand the process of design and shift their mind from a user to a problem solver. The artboard leaves enough space for the participants to innovate. In the brainstorming session, the task is divided into three steps: I like, I wish and What if. The origin of these steps is design thinking activities, which are already mentioned in the theoretical framework.

Another change is that adding one technology poster (Figure 17). Currently, the automotive industry is still technology-oriented. Technology is regarded as an essential part of the design process. Therefore, I tried to encourage the participants to generate innovative ideas by letting them know about advanced technologies. At the same time, I am also curious about what the users think of these advanced technologies. The collections of these technologies come from the internal company and research of the trend of the automotive industry.

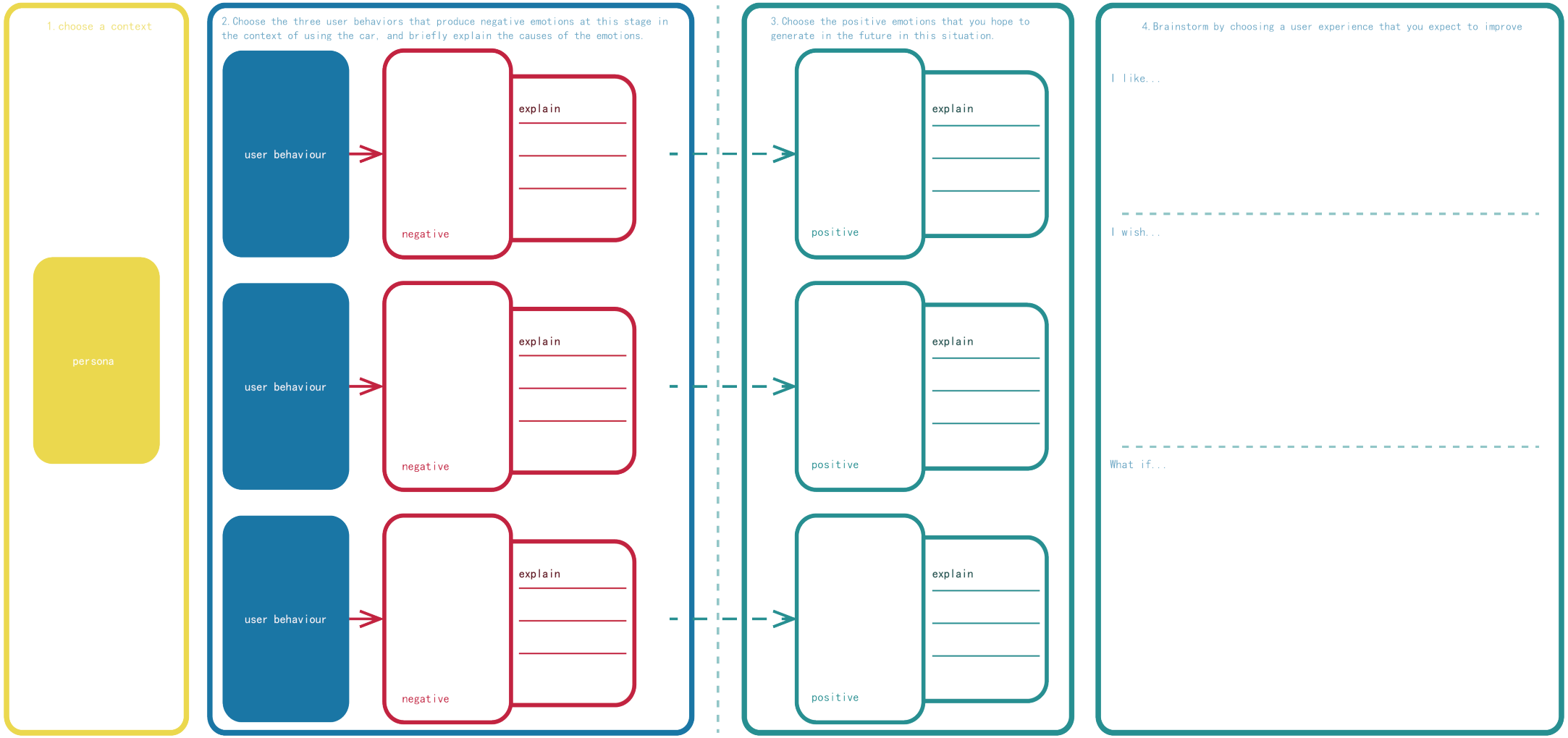


Figure 16. *The second version of the artboard.*

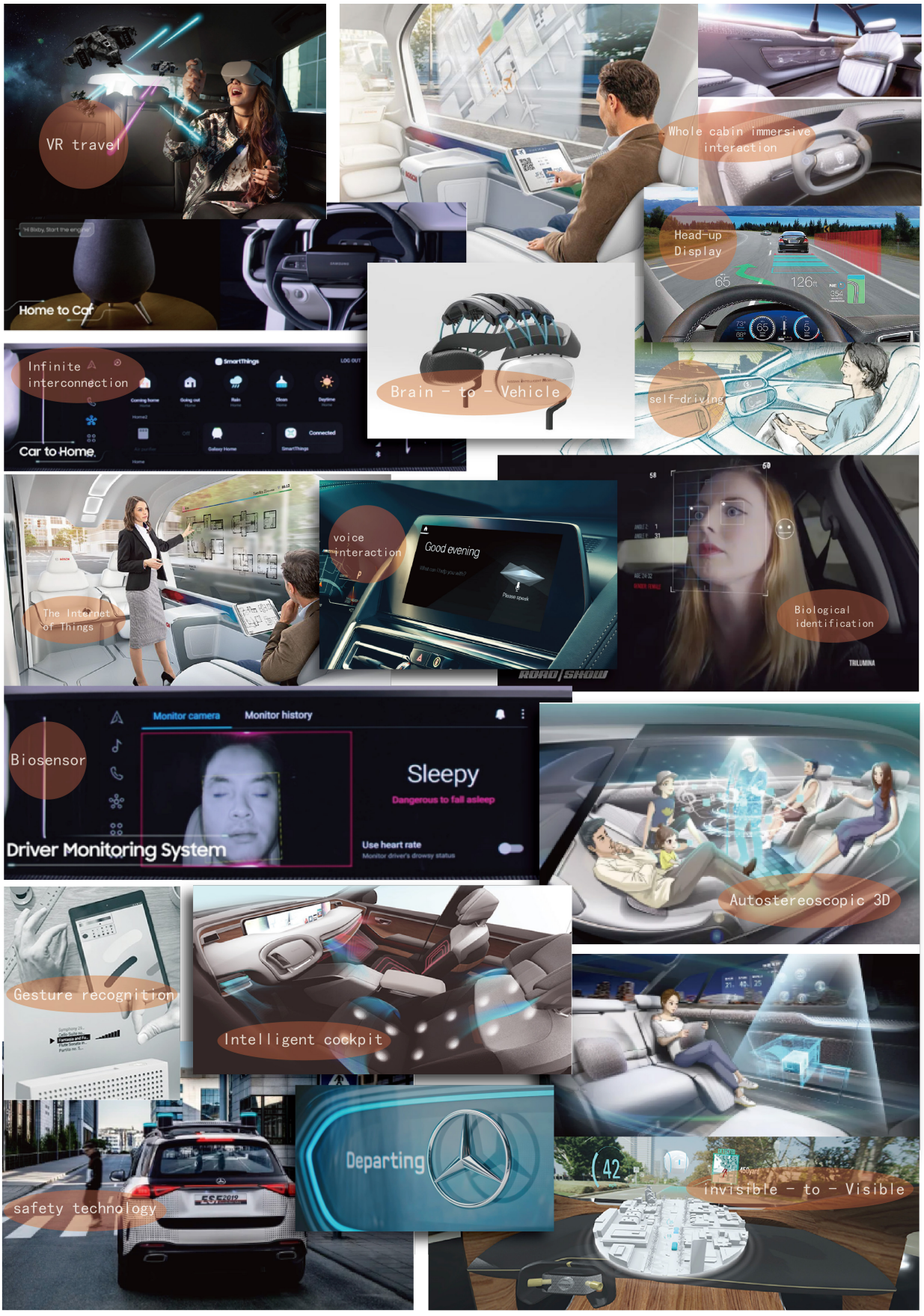


Figure 17. *The technology poster.*

5.2.2 Second Evaluation

Process

Participants: 2 (one female, one male)
Scenarios: commuting and family short-distance trips.
Time: 21.12.2019, around 40 minutes.
Place: coffeehouse

Different from the first workshop, the schedule of the workshop is changed. In total, it is 35 minutes, including 15 minutes to discuss the current problems, 15 minutes to imagine the future, and 5 minutes to get feedback.

The second workshop recruits two participants at the age of 24. One has the driving experiences, while the other does not have driving experiences. Most of the scenarios of the two participants are commuting in the city and family short-distance trips. Because the participants have already known each other, so in the welcome session, it saves time for them to get acquainted with each other. Then in the introduction part, I introduced the purpose of the workshop, the toolkit, and the process of the workshop. After having a basic understanding of the project, the participants agreed to sign the consent form.

During the workshop, firstly, the participants were asked to choose a persona from the cards, which is most relevant to their experience. The participants quickly chose the ***family*** because both of them have the habit of driving with families on holiday.

Secondly, the participants chose three user experiences that produce negative emotions currently: ***working, parking, and driving***. They believed that these experiences remain problems, and often happen in the current travel experience.

Then, the participants browsed the negative emotion cards. After discussion, the participants chose one negative emotion card for each experience and briefly wrote down the reason on the sticky notes (Figure 18). The three negative emotion cards are agitation, tired, unmotivated.

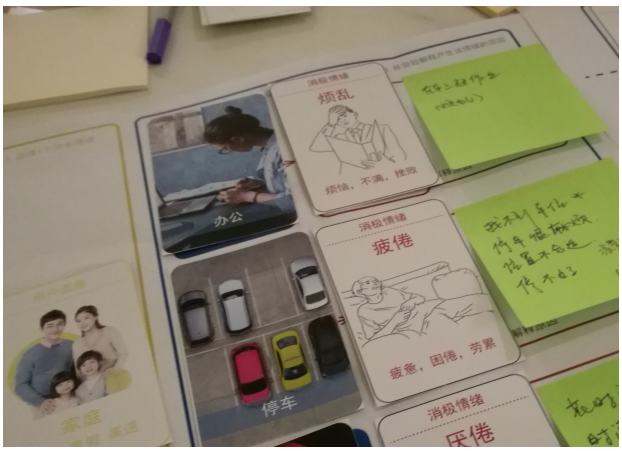


Figure 18. The participants chose three negative emotion cards to match each experience.

(1)"Sometimes I have to work overtime. Even on weekends, I will take my laptop to travel and work in the car."
(2)"Finding parking space wastes lots of time. I am not good at parking; some parking spaces are difficult to park."
(3) " I think waiting for the traffic light is boring. If it takes too long to wait, I will get distracted."
(translated from Chinese)

After that, for each experience, the participants selected three positive emotion cards that they hoped to generate in the future and recorded the reasons on the sticky notes (Figures 19-20). The three positive emotion cards are euphoria, energetic, amusement.

(1) "I would like to feel motivated and enthusiastic while working in the car."
(2) "I hope there are hints for the empty parking spaces, and the layout of the parking spaces can be improved."
(3)"I wonder how can I kill time while waiting for the traffic light. Why not create a city system with big data, that can count time and suggest the best route? For example, it can suggest the driver keep the speed as 60km/h and drive on the exact route, and then the driver can avoid all the red light."
(translated from Chinese)

Before brainstorming, I provided the advanced technology poster to the participants and explained the technologies to the participants, to let the participants know more about the advanced technologies used in automotive design and encourage the participants to open their minds. Then the participants wrote down their expectations and ideas individually (Figures 21-22). After that, the participants shared their ideas (Fugure 23). Throughout the process, both participants actively

and gladly shared their opinions. Especially in the brainstorming stage, the participants would associate with their knowledge or examples they have learned. For example, one of the participants mentioned the Audi concept car, which has a ball shape tire and the traffic light design in the Netherlands. Moreover, in the context of working, the participants hoped the in-vehicle space can be changed to working mode, for example, the laptop is no longer needed, or any surface in the car can be the screen.

Figure 19. *The participant is browsing and choosing the positive emotion cards.*

Figure 20. *The participants follow the instructions and actively discuss in the group.*

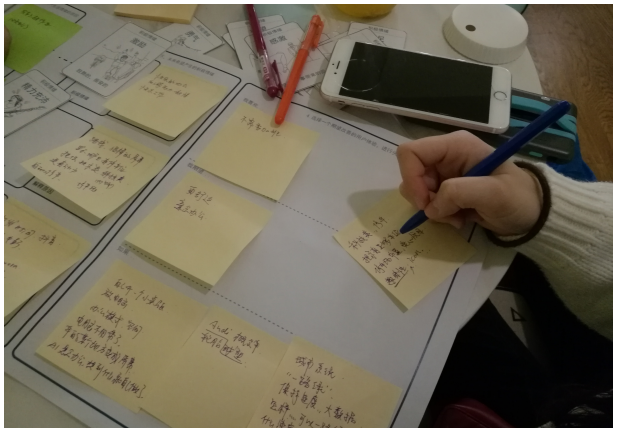


Figure 21. *The participant is writing down her ideas individually.*

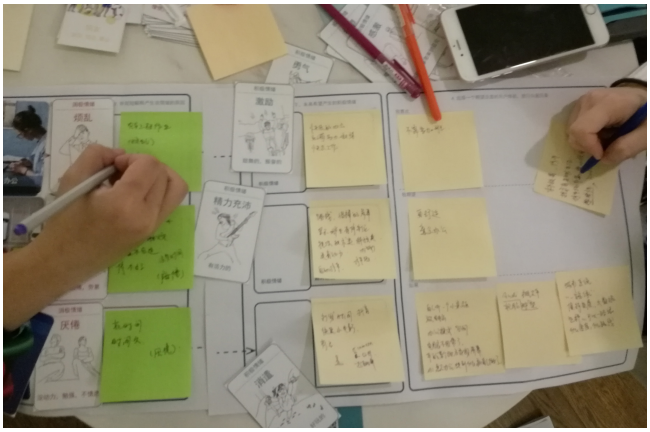


Figure 22. *The participants are writing down their ideas individually.*

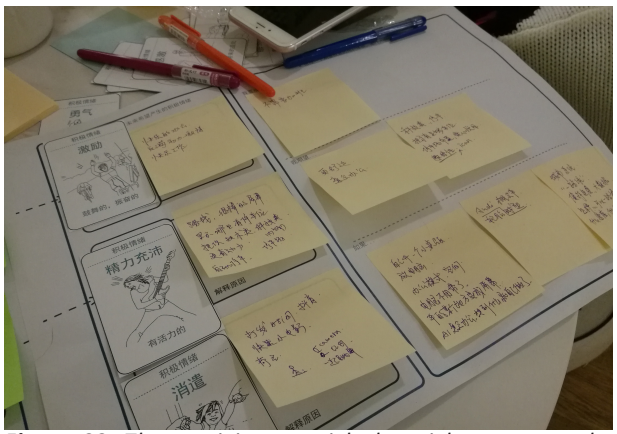


Figure 23. *The participants stick the sticky notes on the artboard and share their ideas.*

Findings

After the workshop, I collected the opinions and advice from the participants. The participants put forward several constructive suggestions.

(1) The participants thought there were repetitions between personas. They mentioned that instead of imagining the persona's experiences, they preferred to recall their own experiences. Therefore, the participants suggested that the researchers and designers should create the persona after the workshop.

(2) *"At first, I thought I need to choose one of these technologies to do the next task." " After the explanation of the technology, I still feel the technology not helpful."* (translated from Chinese)

The participants are confused about the advanced technology poster because they did not know these technologies, and they did not know how to apply them in design. At first, one participant thought she needed to choose one technology from the poster and apply it in her ideas. However, although I have already explained each technology to the participants, they were not able to fully understand them in a limited time. In other words, the participants prefer to rely on their experiences instead of learning new knowledge at this stage. The outcomes of the workshop show that the participants are more concerned about how to improve the experience than how to apply advanced technology. From the users' perspectives, the results are more critical than the approaches. By contrast, for the experts, it might be better to use technology cards than emotion cards. However, for ordinary users, emotion is better to trigger their memories and ideas, rather than providing them new knowledge in a limited time.

(3) With the iteration of the artboard, the layout is changed from horizontal to vertical. This time the participants did not regard the artboard as the timeline, which means that the iterative toolkit has been improved to enable the participants to understand better. However, the participants interpreted the task as choosing three emotion cards to correspond to three experiences. In other words, the participants only chose one emotion for each experience which limits their minds. In the feedback session, the participants said that they regarded the block as a hint for choosing the cards. Because there is only one block next to each experience, they chose the most suitable card among the cards deck, even though there were other cards they would like to choose.

5.3 Third Toolkit Design and Workshop

5.3.1 Toolkit Design

The first and second workshops test the practicability of the toolkit. By observing and inquiring the participants, I note the problems that occurred in the workshops and collect the participants' suggestions. After iterations, the third toolkit is more explicit and more accessible for the participants to understand.

(1) Skip the step of choosing a persona. Because in the previous workshops, the participants preferred to share their own stories, rather than create a fictional character. It is hard for them to put themselves in a fictional situation. Moreover, in the previous workshops, the participants pointed out that they are not sure about the standard of choosing persona cards. Therefore, it will be easier for the participants only to recall their own experiences. The suggestion from the participants is that the persona should be analysed and summarized by the designers after the workshops, according to the participants' position, gender, age, and interests.

(2) Instead of having all the tasks on one large paper, the artboard is separated into 11 experience tasks, printing on half A4 size papers. As shown in Figure 24, each paper is divided into four parts: experience, problem space, expectation, and three magics. The participants could write on sticky notes and stick them on the task papers. In total, there are 11 task papers, which means 11 user experiences. Besides, the schedule of the workshop and the arrangement of each part have been redesigned. In general, to guarantee the participants have enough time to discuss and ideate, choosing three tasks is the best choice in the 90 minutes workshop. As the discussion goes on, when the participants are familiar with the task, the participants will immerse into the discussion, and they will be more willing to share their experiences and ideas. Additionally, explore the current problems by selecting negative emotion cards and dig the potential expectations by selecting positive emotion cards.

(3) Different from the second artboard, the title of the brainstorming part is changed to "three magics". However, the core idea of three magics is still "I like, I wish, What if". During the previous workshop, I noticed that participants were not able to distinguish these phrases and would combine these three parts then generate ideas. Therefore, in the third version of the toolkit, I named the brainstorming part as "three magics", which is abstract but will not limit participants' creativity.

The participants can write down or sketch whatever is in their minds. Realistic approaches and advanced concepts are all welcome. The word "three" does not mean that the participants must come up with three ideas. It encourages the participants to produce as many ideas as possible.

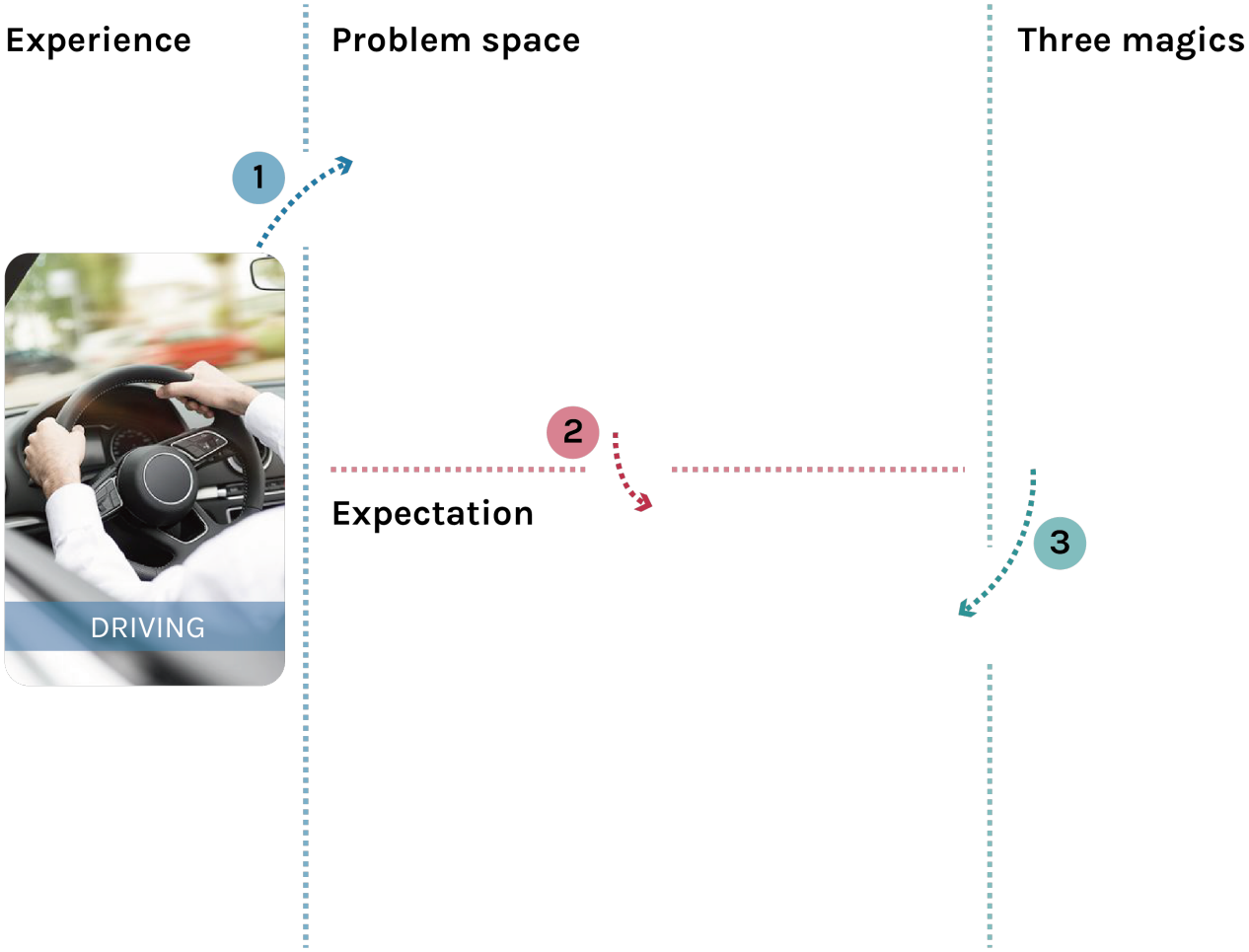


Figure 24. *The example of the third version of the artboard , and the eleven artboards will be shown in the Appendices.*

(4) The advanced technology poster is removed because in the second workshop, the poster does not encourage the participants to generate new concepts, and it causes the participants' confusion. I realized that the participants focus more on the results than on the approaches and providing them with the information of technology approaches in advance will limit their minds. Therefore, the third toolkit will remove the technology poster and leave enough ideation spaces for the participants.

5.3.2 Workshop

Process

To evaluate the third toolkit and engage users in design, I held six workshops and recruited 25 participants, including 10 males and 15 females. The main scenarios of all these participants are commuting, short-distance trip and long-distance journey. With the diversity of background and interest, the age of the participants is between 20 and 80. In total, 14 participants have driving experience. To recruit the participants, I created a poster (Figure 25) and an online registration form (Figure 26). In the registration form, the participants were asked to fill their basic information and choose their suitable timeslot. After receiving these registration forms, I arranged the number and schedule of participants in each workshop, then sent messages to each participant to confirm. The following section will list the basic information about each workshop.

Figure 25. *The recruitment poster. The originial version is in Chinese.*

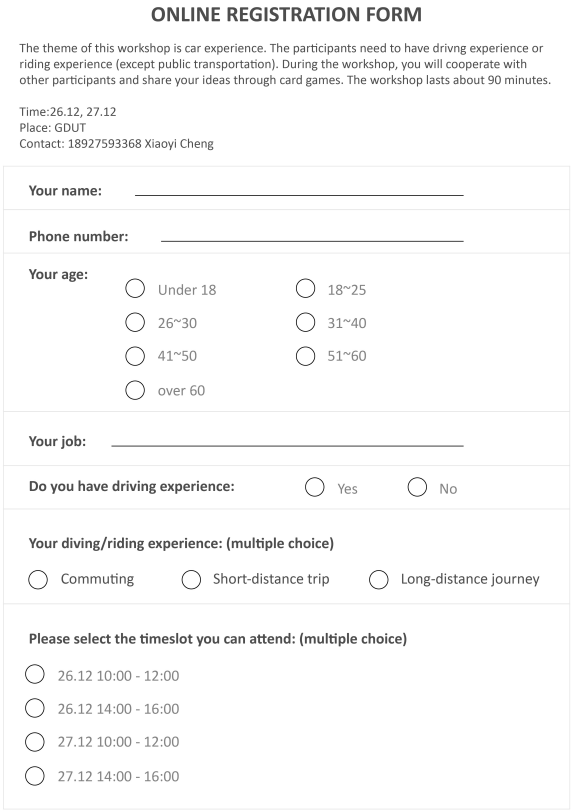


Figure 26. *The online registration form. The original version is in Chinese and posted on the Chinese survey website.*

Participant	Features	Time	Place
Danzi Fang Yanying Guan	Two office ladies. One of them has driving experience but is not good at driving.	24.12.2019, in the evening, around 60 minutes.	Coffeehouse
Wenru Huang Xiaolong Lin Shicheng Fei Hong Zhang Minyu Lai	Five undergraduates. The five participants are divided into two groups. One group has driving experience, and the other group does not have driving experiences.	26.12.2019, in the morning, around 90 minutes (Figure 27).	One workspace in the Guangdong University of Technology (GDUT)
Zezhong Yu Yijia Wei Yiming Li	Three undergraduates. One of them has driving experiences.	26.12.2019, in the afternoon, around 120 minutes.	One workspace in GDUT
Jieying Zhang Aiqin Liang Qinghua Ye Xueer Chen	Four undergraduates. The four participants are divided into two groups. Each group has one participant with driving experiences.	27.12.2019, in the morning, around 90 minutes (Figure 28).	Coffeehouse
Rundong Xie Yiman Chen Jinrong Chen Disheng Lin	Four undergraduates. The four participants are divided into two groups. Only one participant has driving experiences.	27.12.2019, in the afternoon, around 70 minutes.	One workspace in GDUT
Weidong Liu Mianhong Liu Ying Zhang Niansi Liu Xianming Cheng Zhongqi Liu Riying Huang	Seven participants. The first group recruits three participants; all of them are experts in the automotive industry. The second group has three middle-aged people with diverse backgrounds, while the third group has one 80-year-old lady and another middle-aged woman. Except for the 80-year-old lady, all the other participants have driving experiences.	28.12.2019, in the evening, around 110 minutes.	The participants' private space.

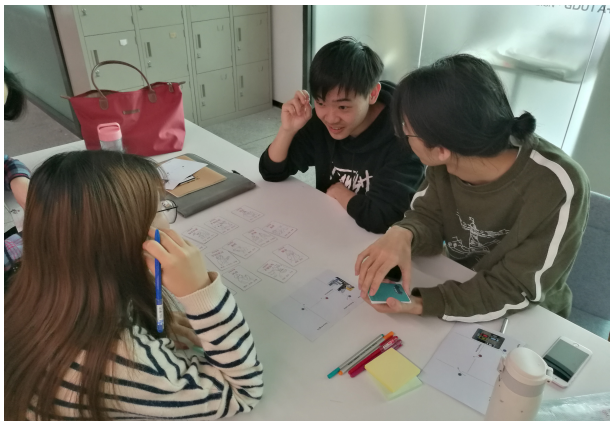


Figure 27. The participants are working in the workspace in GDUT.

Figure 28. The participants are working in a coffeehouse.

To successfully moderate the workshop, before the workshop, I created the instruction of the workshop process. In the workshop, I followed the instruction to facilitate the workshop and control the time. The instruction takes the following steps.

Warm-up (5 minutes)
(1) Welcome all the participants and introduce the topic of the workshop.
(2) Ask permission to take photos for documenting and analysis, to make sure every participant feels comfortable to take part in this research activity.
(3) Explain the tasks and provide the toolkit to each group.
(4) Each group chooses one participant to take notes.

Task 1 (around 60 minutes)
(1) Discussing with the group members, based on the participants' own experiences, choose three experiences that they would like to improve in the future.
(2) Choose one of the three experiences.
(3) Browse the negative emotion cards and discuss what kind of negative emotions are currently produced in this experience. In this step, the participants discuss in the group and share their stories.
(4) Browse the positive emotion cards and discuss what kind of positive emotion they would like to achieve in the future. In this step, the participants begin to depict the future.
(5) The brainstorming part is divided into two steps. Firstly, the participants are asked to write down or sketch their ideas on the sticky notes individually. Secondly, the participants share their ideas in the group. In this step, the participants think about the approaches to solve the current problems or achieve their expectations.
(6) Finish the three experiences one by one.

Task 2 (around 15 minutes)
(1) Present their work and share them with other groups. Discuss which experiences they have chosen and how do they want to improve or achieve.

Feedback and summary (around 10 minutes)
(1) Ask participants 7 questions to get feedback on the workshop. The participants individually write down their answers on the paper. The feedback is anonymous.
(2) Thanks to all the participants and give them gifts.

Findings

At the end of the workshop, I asked the participants seven questions to get feedback on the workshop (Figure 29). The seven questions are:

(1) Do you feel engaged in the workshop? Are you satisfied with your participation? Do you think everyone has the chance to express themselves?
(2) Do the tasks and cards help you recall your own experiences?
(3) In the process of discussion, through the narration of the group members, does it remind you of your own experience, resonates or arouses new ideas?
(4) Do the different emotion cards help you dig deeper into problems and expectations?
(5) Do the words and pictures in the card help you understand the meaning of the emotion?
(6) Does the workshop process help you think in a short time? Are there any doubts?
(7) Write down what needs to be improved.

The following sections will list several answers to these questions and evaluate the workshop and toolkit based on my observation and the feedback from the participants.

Figure 29. *The participants is writing feedback on the paper after the workshop.*

(1) All of the participants felt engaged in the workshop.

"I felt relaxed. It is not intensive, and I thought I came here to chat with the other participants."
"I felt more engaged than an interview. In the middle and late stage of the workshop, I am in a higher spirit."
"Because some people are not good at talking in a group, I think they need a facilitator to help them or give them the chance to share."
"Without pressure, the discussion is like chatting."
(translated from Chinese)

During the workshop, I observed that all the participants actively discussed and were willing to share their stories. From my perspective, the main reason is that the participants in each group know each other. Because the group members already know each other, it not only saves plenty of time to introduce every participant but also makes the workshop more efficient. Although most of them are not familiar with me, they still feel comfortable to engage in the workshop with their friends.

Most of the participants are satisfied with their creativity and engagement. At first, I worried that the participants would lose patience in the process since the 90 minutes workshop takes more time than the ordinary interview. However, through the observation and feedback, I noticed that most of the participants actively took participant in the workshops.

Moreover, I noticed that the younger participants are more willing to take notes by themselves (Figure 30), while the middle-aged participants would ask me to take notes for them. In the last workshop, to guarantee the content of the discussion is recorded, when I realized that participants were not willing to take notes, I would take notes for them (Figure 31).

However, even the rules of the workshop were introduced at the beginning; some groups did not follow them exactly. I noticed that it would be better if each group has a facilitator to record the discussion process, solve the participants' confusion and facilitate the workshop process.

Figure 30. *The participants are taking notes by themselves. One of them is browsing the cards, while the other is taking notes.*

Figure 31. *The last workshop was held in the participants' private space. I am taking notes while the participants are discussing.*

(2) The toolkit build the standard language for participants

"During the process, I can quickly substitute myself in the corresponding scene or memory and produce innovative ideas with the help of the tasks and cards."
"The keywords on the cards can quickly help me to recall experiences. Group discussions can quickly identify the main problems."
(translated from Chinese)

With the help of the toolkit, most of the participants feel engaged in the workshops and satisfy with their outcomes. After several iterations, the third toolkit includes the task papers and emotion cards. From the participants' point of view, the tasks are easy to understand and follow. The participants praise the toolkit since the workshop is not like an ordinary interview. The cards help them quickly build the language and start to share their own stories. The tasks encourage them to focus on specific experiences. Although the third toolkit does not include the technology poster, the participants would think of some examples that they had seen in movies

or magazines.

When the participants thought about the negative emotion cards, they began to recall and share their own experiences with others (Figures 32-34). The emotion cards play the role of triggers; they do not mean a specific emotion. The participants may have different understandings of the contents of the cards. During the workshop, a clear explanation enables facilitating the process (Figure 35). Sometimes the participants were not limited to a specific scenario. They always thought outside the box.

Figure 32. *The participant is browsing and choosing the negative emotion cards individually.*

Figure 33. *The participant is browsing and choosing the negative emotion cards together.*

Figure 34. *The participants are discussing the negative emotion cards and sharing their experiences, one of them is taking notes.*

Figure 35. *I am explaining the meaning of the cards to the participants.*

Moreover, using the emotion cards is beneficial for gaining a deeper understanding of the user from an emotional point of view. The participants found that toolkit could explore their subconscious emotions. However, the participants have a different understanding of the pictures and the descriptions on the emotion cards. The minority of the participants pointed out that some of the pictures are too concrete and limit their thought.

(3) Discussion encourages the participants to recall experiences and generate ideas.

"Yes, I have the chance to express myself, the group members are talkative, and our group has a pleasant conversation. Furthermore, the discussion reminds me of my experiences."
"In the process, we can carefully listen to other participants' stories."
"It also relies on the imagination and creativity of the group members."
"I think communication can stimulate ideas, and the process is simple and smooth."
"I think it will be better if there are three members in a group. Because our group only has two members, thus our minds can be limited. When our opinions are in conflict, we need another person to mediate. In life experience, one more person brings one more possibility. "
(translated from Chinese)

All the participants thought the group discussion helps them generate innovative ideas. Through the discussion, most of the participants thought the tasks and cards help them recall their own experiences. At the first step of the workshop, the participants discussed and decided on the tasks by initially recalling their experiences. As the task goes on, they would have a more in-depth conversation (Figures 36-37).

Figure 36. *One of the participant is sharing her stories, while the other one is taking notes. These two participants do not know each other before the workshop, but as the task goes on, they are more willing to share their stories.*

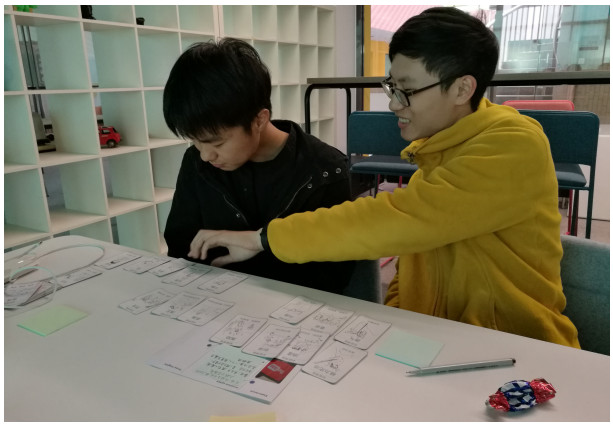


Figure 37. *The participants spread out all the cards, and discuss the cards one by one.*

I observed that each group had a different discussion atmosphere, some of the groups spent more time on individual thinking, while other groups preferred to discuss actively. The participants found that discussion not only reminds the participants of their current experiences but also reminds them of their childhood stories. In the discussion, frequent conversations are:

"I have a similar story..."
"I also experienced it once..."
"That is what I think."
"As we mentioned before."
"Once my mom..."
(translated from Chinese)

Also, the participants associated their own experiences with news and other people's stories. In particular, the participants would be surprised and excited if they come up with similar ideas, and the participants would praise each other if they come up with novel ideas. One of the participants highly praised their group work. In the ideation stage, it was surprised to find that her group members had similar ideas with her. Besides, when the group members described their ideas, other participants would actively participate in the discussion and added their suggestions.

Generally, if the participants feel more engaged and motivated in the discussion, their group will generate more fascinating ideas. After the participants finished their ideation, they were delighted to share the ideas among the group and were also curious about the other members' ideas (Figure 38). However, in the brainstorming stage, there was one group that preferred to discuss firstly, and then one of them took notes of their discussion (Figure 39).

Figure 38. *After the individual ideation, the participant is sharing her ideas with the other, and using the pen as the tool to explain her idea in detail.*

Figure 39. *The participants in this group prefer to discuss the ideas together while one of them is taking notes, instead of having individual ideation firstly.*

(4) The emotion cards dig deeper into the demands of users.

"With the help of the cards, I will not think aimlessly. I think it is efficient."
"It can promote the exploration of deep problems, but the explanations of some words are not clear enough, the group members had a different understanding of the words."
"To some extent, cards break the scene into a specific action so that we can look back to our experience in detail. Nevertheless, the group member may differently interpret and define the cards."
"There were so many cards that it took much time to select them."
(translated from Chinese)

Most of the participants point out that it is easy to recall one's experiences and imagine the future through emotion, the cards are playful, but some of them have higher expectation.

I observed that when the participants discussed the positive emotion cards, they thought about the negative emotion and the problems at the same time. While discussing the problems and expectations, some of the participants preferred to take notes by themselves to keep the discussion and ideas in mind. When the participants browsed the positive emotion cards and depicted their expectations, they were more excited. For instance, "I would like..." is the starting point of their ideation (Figures 40-41). However, the participants suggest that emotion cards can be designed more attractively, and it may be better if the cards are used as a game.

Figure 40. *One of the participant is showing the positive emotion cards to her group and sharing her stories.*

Figure 41. *The participants spread out all the positive emotion cards. One of the participant is depicting her expectation, while the other one is taking notes.*

(5) It is easier to understand with the combination of descriptions and pictures.

“I think it is useful. At first, the words and pictures are abstract for me, but it also helps me think out of the box. I hope it can be more interesting."
"The description and pictures help me understand, but some of them are too concrete to limit my imagination."
"Sometimes, the words are more useful than pictures."
(translated from Chinese)

Different participants have a different understanding of the cards. Their understandings of the pictures are based on their own life experience. Sometimes the pictures make the participants fall into a specific scene. For instance, during the discussion, one of the participants asked me "is this Justin Bieber?", and the handsome character on the card reminds her of the experience that once she watched her idol's tv show in the car (Figure 42). However, I did not have such an idea when designing the card. Another example is that one of the participants said the picture on the “Distrust” card is so lively that it reminds her of a scene in a TV show (Figure 43).

Besides, the combination of description and pictures helps the participants to understand. For example, although on the "Rest" card the passenger is sleeping, it does not only mean sleep, it also means "take a break" (Figure 44). During the workshop, when the participants encountered problems, they tried to figure out by asking me directly or combining them with pictures to understand by themselves.

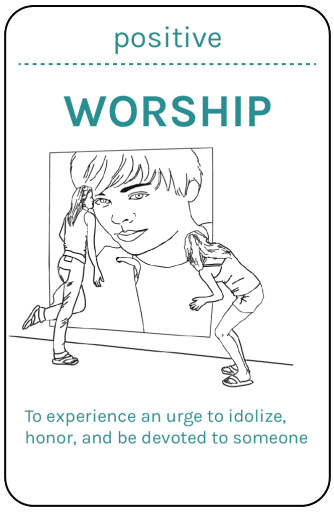


Figure 42. *The card reminds the participants of her experiences of watching her idol's tv show while riding.*

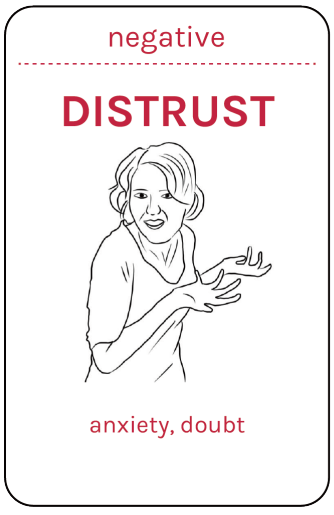


Figure 43. *The card reminds the participants of one scene in a TV show.*

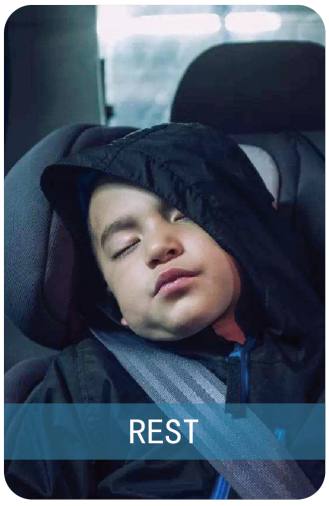


Figure 44. *Although in the picture, the passenger is sleeping, the card also means "take a break".*

(6) The workshop process is smooth and easy to understand

"The tasks help me put myself in specific scenarios and let me think step by step."
"When we were describing the problems, we also talked about our expectations. On the contrary, when we were discussing our expectations, we also thought of the problems we met in daily life."
"When we talked about the current problems, I took notes and thought about how to solve them at the same time. I did the same thing when we were talking about expectations. With the help of the notes, in the last step, I could generate ideas more efficiently."
" The other group finished in advance, which gives us pressure."
(translated from Chinese)

In the introduction stage, the participants gain an overview of the workshop and the toolkit. With the brief introduction, I noticed that the participants had a basic understanding of the workshop but were still confused about how to use the toolkit. Therefore, the first round usually takes more time. During the first round, the participants need to learn how to use the toolkit and finish the task. However, after finishing the first round, the participants were familiar with the task and toolkit. Hence they knew how to facilitate by themselves and complete the tasks in a shorter time. The figures below shows the several outcomes of the group discussions (Figures 45-48).

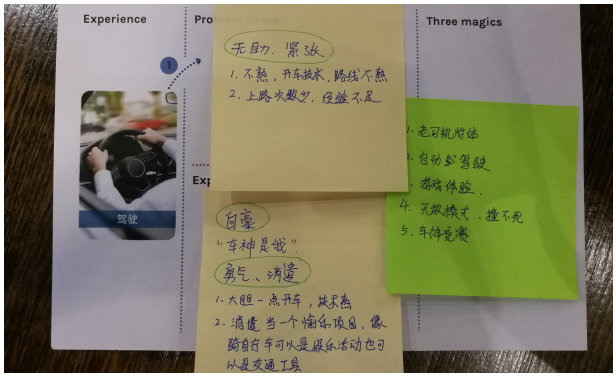


Figure 45. *The outcomes of one group about driving experience.*

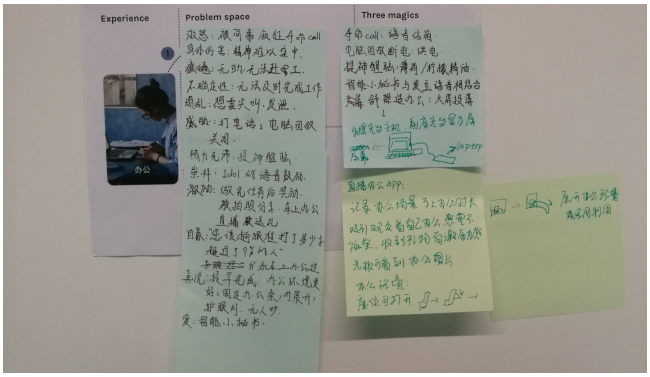


Figure 46. *The outcomes of one group about working in-vehicle experience.*

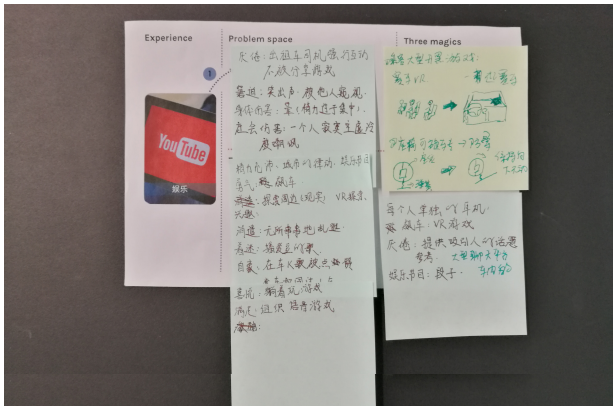


Figure 47. *The outcomes of one group about in-vehicle entertainment experience.*

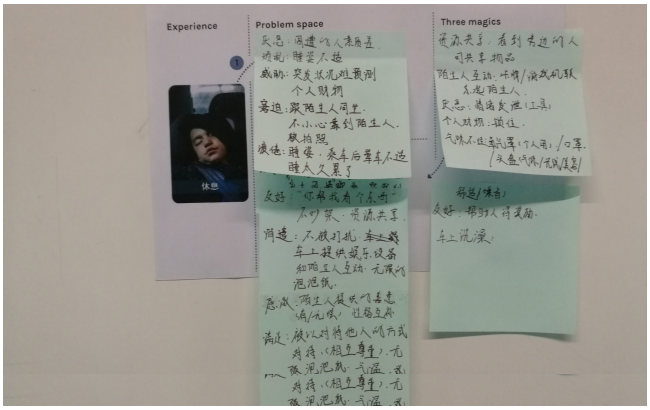


Figure 48. *The outcomes of one group about rest in-veicle experience.*

In the ideation step, most of the participants thought it is more efficient to think independently first, and they would look back to the sticky notes they wrote earlier and think much more in-depth (Figures 49-51). Furthermore, if the two groups choose the same experiences, the groups would be curious about the creativity of the other group. On the contrary, if the two groups choose different experience tasks, they would be more curious about the current problems rather than creativity (Figure 52).

Additionally, in the fifth workshop, one group finished in advance and began to chat and had snacks, while the other group was still working. Therefore, one of the participants pointed out that because they were immersed in their discussion when they noticed the other group finished earlier than them, he started to feel nervous and tried to finish the tasks quickly. Although there was still time left, the participants will feel pressured by the progress of the other group. Thus, the participant suggests the facilitator balance the time spent by the two groups.

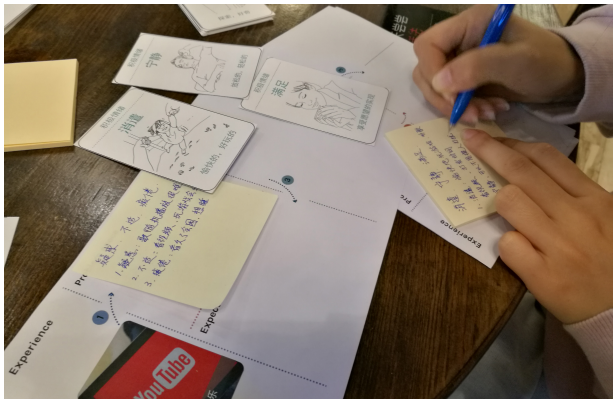


Figure 49. *In the ideation step, firstly, the participant is writing down her ideas and expectations individually.*

Figure 50. *In the ideation step, firstly, the participants are writing down their ideas individually.*

Figure 51. *In the ideation step, the participants look back to the problems and expectations they wrote before, while writing down their ideas,*

Figure 52. *In the end of the workshop, the two groups discuss together. Because they chose different experience tasks, they were more curious about why the other group chose those cards.*

5.4 Summary

5.4.1 Evaluation of toolkit and co-design activities

Evaluation of the toolkit.

The tasks should not be too difficult; otherwise, the participants will feel upset. Whether young or old, the toolkit should be playful that everyone can play with them. More precise instruction can make the workshop process smoother. Moreover, the workshops confirmed that emotion could be the trigger to explore the users' subconscious. As mentioned in the desktop research, users will have different emotions when using a product. For the non-designer, distinguishing the nuances of emotions helps them to identify problems and explore demands.

If the participants choose more cards, they will come up with more ideas, but it also costs more time. With the help of the toolkit, the non-designers can complete the design tasks in a short time. Although the participants do not have professional design competence, they can generate innovative ideas by themselves. The participants have different backgrounds, and most of them have limited knowledge about the automotive, however, in the workshop, the toolkit assists them in building a common language which makes them feel engaged and are willing to share.

Evaluation of the co-design activities.

In total, the toolkit is iterated twice, based on the feedback of the participants and observation of the workshops. By reducing parts of the toolkit, the third version is designed as simple as possible, to guarantee the toolkit is more accessible for the participants to understand.

In order to let the participants have a basic understanding of design, the workshop is divided into three steps. In the first step, the participants feel free to share their previous experiences and find current problems. During the second step, the participants are asked to imagine the future and express their expectations; while in the third step, the participants generate ideas and present them to the group. The initial toolkit emphasizes the current problems and users' emotions; but the iterated toolkit balances the past and the future, giving participants more spaces to create.

From my perspective, because the participants are non-designers, they need to be facilitated step by step; and the toolkis is the clue for the participants to facilitate

the workshop process. During the creation process, the participants have a sense of achievement.

5.4.2 Outcomes of co-design activities

Overview of the outcomes

In total, **Rest** is selected nine times, followed by **Entertainment** (six times), **Working** (five times), and **Enjoy scenery** (four times). **Driving** and **Social** are chosen three times, while **Parking**, **Get on and off** and **Navigation** are selected twice. Besides, **Sharing car** is selected once because only one participant has the experience of driving a sharing car and wants to improve the service system of sharing-car. Additionally, none of the participants chose **Purchase**, since half of them do not have their cars, and the other participants did not buy cars recently. (Figure 53)

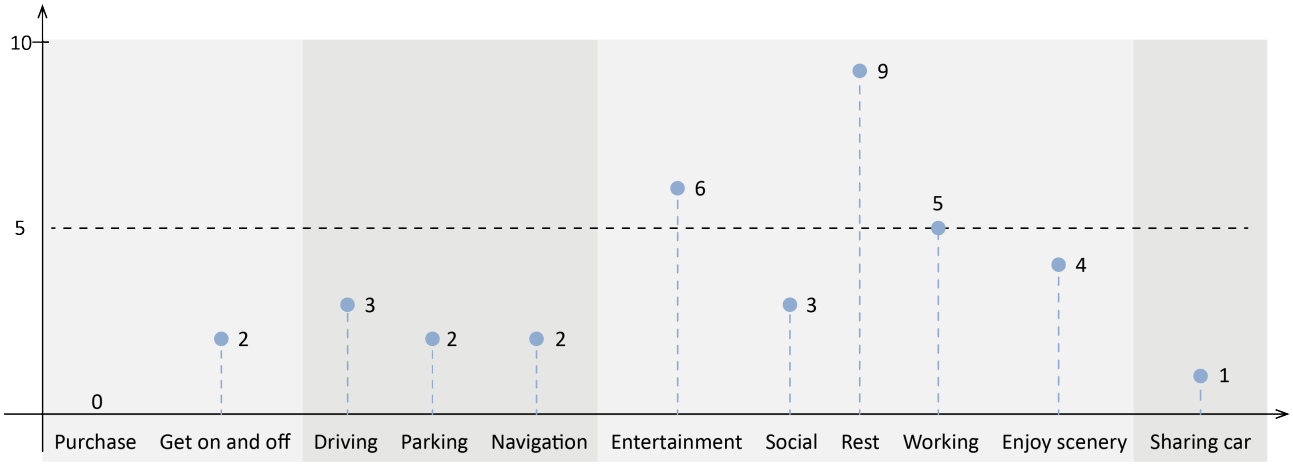
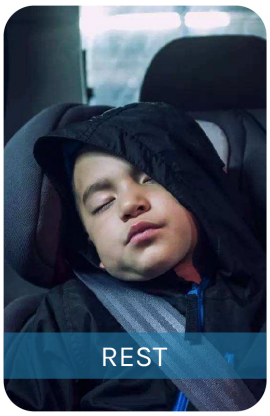


Figure 53. *The figure shows the number of times each experience has been selected.*

With the development of the self-driving car, vehicles will become a living space in the future. Thus, the participants are looking forward to exploring novel riding experiences. Almost all the groups chose **Rest** without hesitation; thus, **Rest** is highly ranked in all the experiences. Additionally, I notice that whether in the context of driving or riding, the participants frequently chose **Rest, Entertainment** and **Enjoy scenery**. After the workshops, I analysed the participants' ideas and expectations, then visualised them. The following sections summarize and present the problems and ideas of each experience raised by the participants in the workshop (Figures 54-59).

Experience



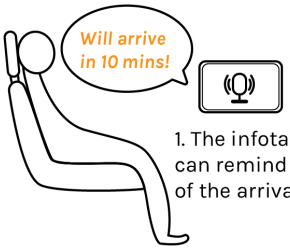
Problem space

1. The uncomfortable posture affects the sleeping quality.
2. Snoring and drooling are awkward; it is embarrassing that the sleeping posture is seen by other passengers.
3.The sudden stop and sudden start will make the passenger hit the head because when the passengers closed eyes, they do not know what will happen, so they cannot protect themselves in advance.
4.The passengers are afraid that car accidents will happen while sleeping.
5.The other passengers or driver suddenly play music loudly.
6.If the driver gets tired, it will be dangerous.
7.Afraid of missing the stop.

Expectation

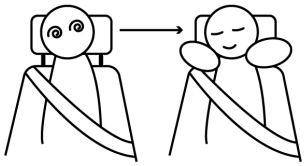
1. The passengers think that they can do lots of things in the car, rather than sleeping.
2. Hope do not be disturbed, rest in peace and relieve tiredness
3. The seats can be more comfortable
4. The seats are flexible that create a perfect space for rest
5. Set appropriate temperature and light
6. Play silent or soft music.

Three magics



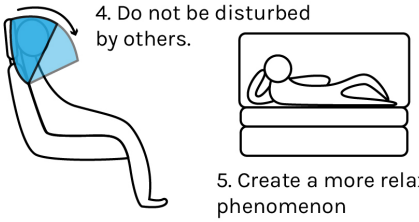
1. The infotainment system can remind the passengers of the arrival time.

2. There is a gas device next to the seat when the passengers need to sleep, it will be inflated in a few seconds.



3. Inform the passengers the arrival time.

4. Do not be disturbed by others.



5. Create a more relax phenomenon

Experience

Problem space

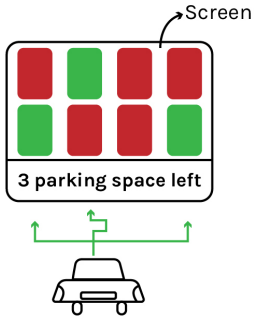
1. It wastes lots of time to find a parking space
2. Bad at parking skills

Expectation

1. Find parking spaces faster.
2. Be praised by others.

Three magics

1. Provide hints for empty parking spaces, for example, showing the empty parking spaces on a fantastic screen.



2. If the tires can be rotated 90 degrees, it will be easier to park.

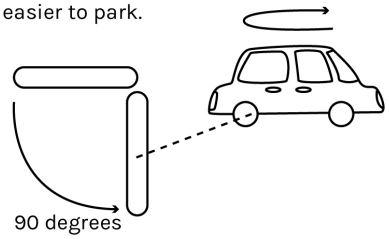


Figure 54. *The design proposal.*

Experience

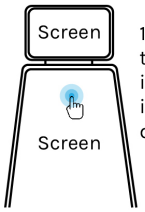
Problem space

1. Watching videos and playing games will cause sickness.
2. The music played in the car cannot satisfy everyone's preferences.
3. Sometimes it will be embarrassing if the passenger would like to have a rest instead of talking with others.
4. The radio plays the song which the passengers do not like.
5. During the long-distance journey, the passengers feel bored without entertainment,
6. Because of carsick, the passenger can only play cards in the car, but others always play smartphone, which will make the passenger feel lonely.

Expectation

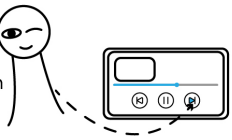
1. Release tiredness
2. The infotainment system can recommend games for passengers to play.
3. Create greater entertainment environment, it will be better if there are VR games.
4. There will be something to support the smartphone, so the passengers do not need to hold it all the time.
5. The passenger wants to watch TV shows, but do not want to be seen by others.
6. Redefine the car, it may be J.A.R.V.I.S. to assist drivers and passengers in the future.

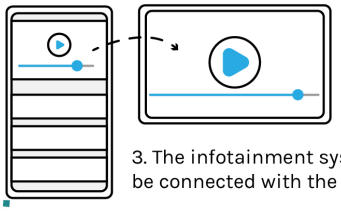
Three magics



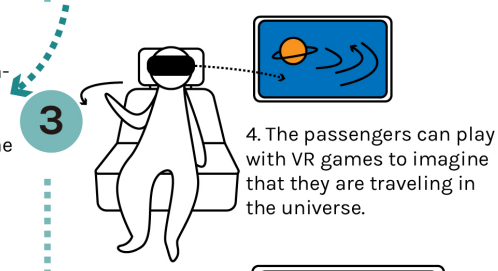
1. The back of the seats can be the screen. And the passengers in the back seat can operate the infotainment system without disturbing the front seat.

2. Posture control, for example, blinking can skip the song.

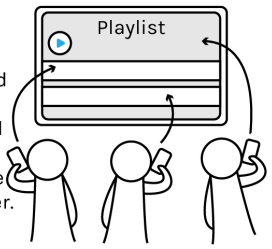




3. The infotainment system can be connected with the phone.



4. The passengers can play with VR games to imagine that they are traveling in the universe.



4. Create an in-vehicle shared music platform, so the driver and passengers can put their favorite playlists together.

5. The in-vehicle system can recognize emotion and help the driver and passengers release by physical or emotional means.

6. Provide immersive experience.

Figure 55. *The design proposal.*

Experience

Problem space

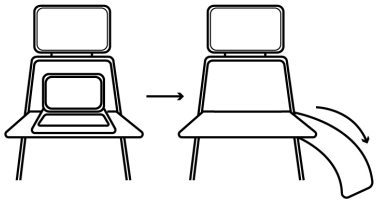
1. The passengers cannot concentrate on work or finish work on time.
2. There is no place for work, which decrease work efficiency.
3. Without the Internet and the laptop is out of power.
4. Will get motion sickness.
5. The environment in the car makes the passengers feel sleepy and bored.
6. Forget something or lost something.
7. Have lots of working phone call, it is difficult to focus on work.
8. Feel embarrassed when getting a phone call from the boss.

Expectation

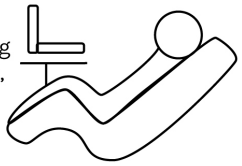
1. Full of passion, feel refresh and finish work efficiently
2. The working space is different from the office; it will be more comfortable and independent.
3. Minimize the working process
4. Want to be appreciated
5. Have a smart secretary

Three magics

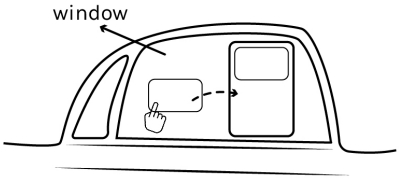
1. Create a space for the laptop.



2. The in-vehicle space can be changed to working mode, for instance, changing the seat position.



3. The window can used as a screen, which allows passengers to quickly record their ideas and lives. And applying voice input and gesture control for working. After finishing the work, the documents can be transferred to the laptop.



Experience

Problem space

1. Sometimes passengers do not know how to open the door.
2. There is no place for an umbrella.
3. The seat is too high or too low, it is difficult for the elderly to get in the car.
4. Might bump into someone when you open the door.

Expectation

1. It is easier to get in the car.

Three magics

1. Create a storage space for an umbrella
2.Safety instruction for opening the door.
3. Barrier-free facilities for elderly.

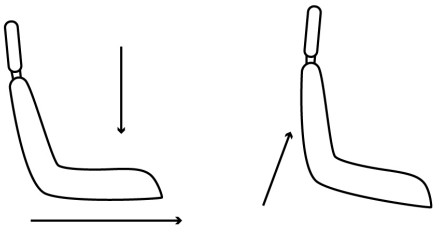
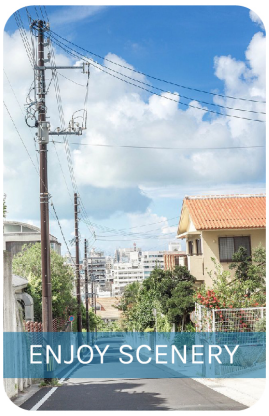


Figure 56. *The design proposal.*

Experience



Problem space

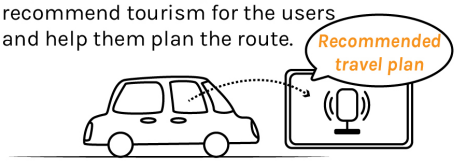
1. It will be embarrassing to make eye contact with people outside the car.
2. It is difficult to take photos in the car.
3. Feel homesick while leaving hometown.
4. Some cars are too big to stand in the way of the view;
5. The same scenery can also be boring, for example waiting in the traffic jam.
6. Blocked by other cars, especially big trucks make the passengers feel dangerous.

Expectation

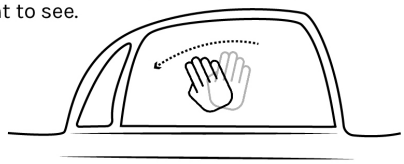
1. Spiritual relaxes
2. Curious about the scenery.
3. The users hope the trip can be more personalized and more fascinating.

Three magics

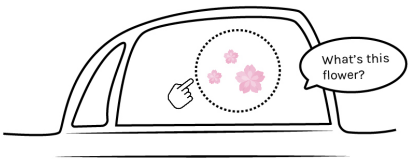
1. Equip a tourist assistant to introduce the scenery along the way. The in-vehicle system can recommend tourism for the users and help them plan the route.



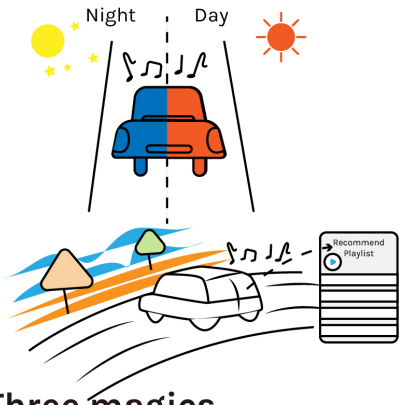
2. Block the scenery if the passenger do not want to see.



3. Capture the scenery.



4. The infotainment system can recommend songs based on the out-window scenery. The in-vehicle system can have the memory function, the system can replay the scenery for the users by pictures or videos.



Experience

Problem space

1. App: the positioning of the car is not accurate;
2. The driving experience is uncomfortable.

Expectation

1. Drive at ease and enjoy driving.

Three magics

1. Improve the app using process and customer service.
2. In order to efficiently find a car, provide the users with more transparent vehicle status.
3. The service process should be simpler and more convenient.
4. The app information structure should be improved.

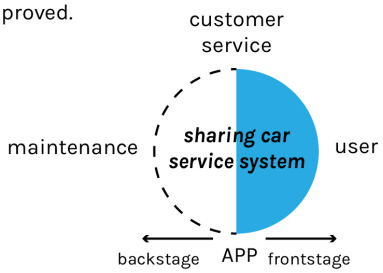


Figure 57. *The design proposal.*

Experience

Problem space

1. Waiting for the traffic light wastes lots of time;
2. Novice drivers are not good at driving or not familiar with the routes.
3. Traffic jams make users feel helpless and tired.
4. The other drivers do not obey traffic rules.
5. One of the drivers used automatic cruise once, but he is afraid of it. Because when something goes wrong, the drivers still need to operate by themselves, it takes time for the drivers to react;
6. Driving alone on the highway makes the drivers feel board.

Expectation

1. The infotainment system can assist the novice driver to improve driving skill
2. The participants said that "When I arrived home, I do not get off the car immediately, I will sit in the car for a while to enjoy the temporary relief."
3. One of the participants mentioned that "I do not agree with the too comfortable environment, because it will decrease my concentration. It will be more dangerous. Drivers should stay focused.

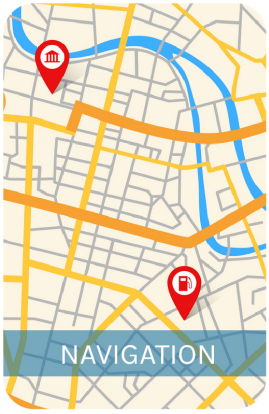
Three magics

1. To encourage the novice drivers. Combing driving with games, and have races with other drivers, which will make driving more fascinating.

2. Design some entertainment for killing time while waiting for the traffic light.

3. Create a city system with big data, which can count the time and suggest the best route. For example, the infotainment system can recommend that if the drivers keep the speed as 60km/h and drive on the specific route, they can avoid all the red light.

Experience



Problem space

1. Inaccurate positioning, especially three-dimensional road conditions
2. The infotainment updating is very slow, so most of the participants only use the navigation app. Besides the app has more functions than the infotainment system.
3. It does not show the exact position.

Expectation

1. Explore the unknown road, and give the driver confidence
2. Avoid traffic jam;
3. Recommend the surrounding parking spaces.
4. The infotainment system can be updated in time because the roads in China changed too often.

Three magics

1. The voice interaction can be more like human communication and the users can ask questions.
2. Record the destinations and creates an annual report.
3. The instructions can be much clearer
4. There will be a place for the cell phone in the car, or the phone can be connected to the infotainment system,
5. The infotainment system will be the display of the phone and the interface is the same as the phone.
6. The infotainment system display can adjust its degree, so both the driver and passengers can use it more conveniently.

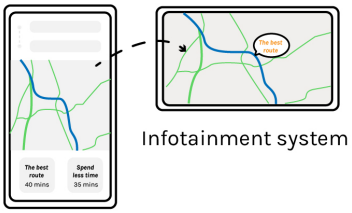
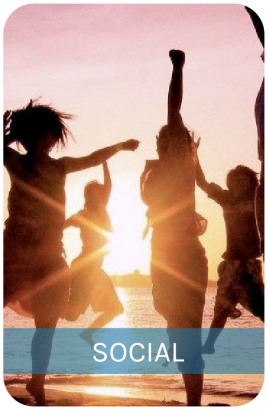


Figure 58. *The design proposal.*

Experience



Problem space

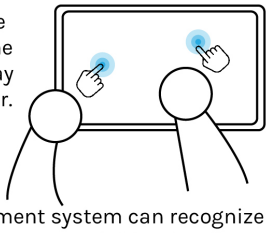
1. When the passengers use the ride-hailing services, it's awkward to chat with strangers.
2. When riding with others the passengers would like to have their private spaces.
3. It is difficult for passengers sitting in the copilot to communicate with passengers in the back seat.

Expectation

1. Happily chat with others.
2. Make friends with other passengers.
3. Fun socializing can be enjoyable.
4. Kill time.

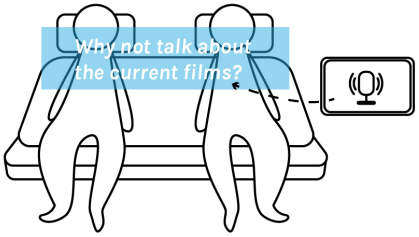
Three magics

1. The in-vehicle screen allow the passengers play games together.

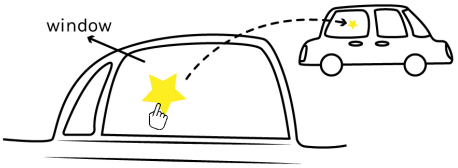


2. The infotainment system can recognize different passengers' and driver's voice.

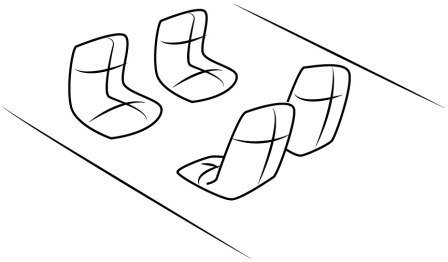
3. The in-vehicle system can recommend topic hints and play relaxing music or radio.

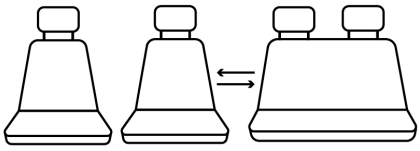


4. Use the windows as the media to achieve the vehicle-to vehicle communication.



5. Redesign the seats to make it more convenient for the passengers to chat, but also need to consider the private spaces.





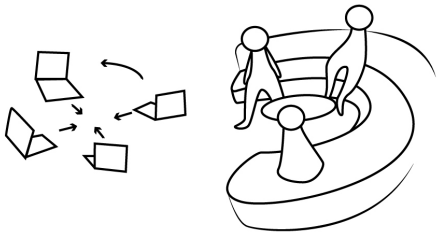


Figure 59. *The design proposal.*

Analysis of the user groups.

The age of the workshops participants covers from 18 to 80, although the sample data is limited, it reveals common behaviours and expectations of the users. Therefore, I believe it is meaningful to categorise the user groups in terms of the outcomes of the workshops. In the following sections, I will analyse the outcomes according to the age groups.

Young users

After analysing the outcomes of the workshops, I realize that users aged between 20 and 30 are more dependent on social media. This kind of users not only desire to have a pleasant conversation with other passengers but also hope to create private space for every passenger. The male users are more interested in advanced technology while the female concentrate on emotional expressions.

Besides, young users expect that the car can provide more entertainment approaches to make the trip more amusing; for example, combining games with driving is mentioned by several participants.

Moreover, as a passenger, most of the young users prefer the ride-hailing service; thus, they often ride with the passengers they do not know. Under this circumstance, the users hope that the in-vehicle space can become a social space.

Likewise, the users hope that the car in the future will be more user-friendly and are able to recognize the emotions of both drivers and passengers. For example, the infotainment system can intelligently recommend songs or radios based on the in-vehicle atmosphere.

Furthermore, because of a lack of driving experiences, most of the young drivers are not good at driving; thus, this kind of users hope that the in-vehicle system can assist driving by giving instructions and encourage them by providing rewards.

Also, a high proportion of young users choose **Working**. Whether it is working on the telephone or using a laptop, the experience of working in a car cannot be ignored. Working in the car causes plenty of problems, and it inevitably happens, although the users are not willing to work in the car. Therefore, the users hope that in-vehicle design should also consider working mode, except for leisure.

Middle-aged users

In general, all middle-aged participants are interested in the development of the automotive industry, but none of them is fascinated with driving. Two of the participants are experts in the automotive industry; however, during the discussion, instead of thinking from the experts' perspective, they put themselves in the users' shoes.

Different from the young users, in the workshop, all middle-aged participants are good at driving and have more than ten years of driving experience. Besides, most of them drive for commuting almost every day. During the workshop, the participants discussed the drivers' experience rather than a passenger. Thus, they emphasize the problems of driving, parking, and navigation. Because this kind of user always plays the role of drivers, they think from the perspective of the drivers rather than passengers. During the rush hour, they generally spend two hours driving, which makes them feel exhausted. However, the middle-aged male users point out that they value their personal time in the car, which is a precious time for them to rest alone. Except for commuting, this kind of user usually has a family trip by car on holiday.

Elderly users

Another user group is elderly users. The workshop only recruits one elderly participant, and the data is limited. However, from my point of view, the elderly users are another indispensable target group, which has unique needs from other age groups. Therefore, although the sample is limited, I believe that this sample is representative. The elderly user concentrates on ergonomics and barrier-free facilities. For example, the user points out that the **Get on and off** experience makes her feel angry. If the seat is too high, it is difficult to get on the seat; and it is inconvenient to get off if the seat is too low. Even if the elderly walk slowly and need to go out by car, she still looks forward to hanging out with family on the weekend. The car makes the travel of the elderly more convenient and provides more possibilities.

By analysing and evaluating the outcomes of the workshops, I classify the personas in terms of age and driving experiences. As shown in Figure 60, I depict four user personas. The following sections will descirbe the personas in detail.

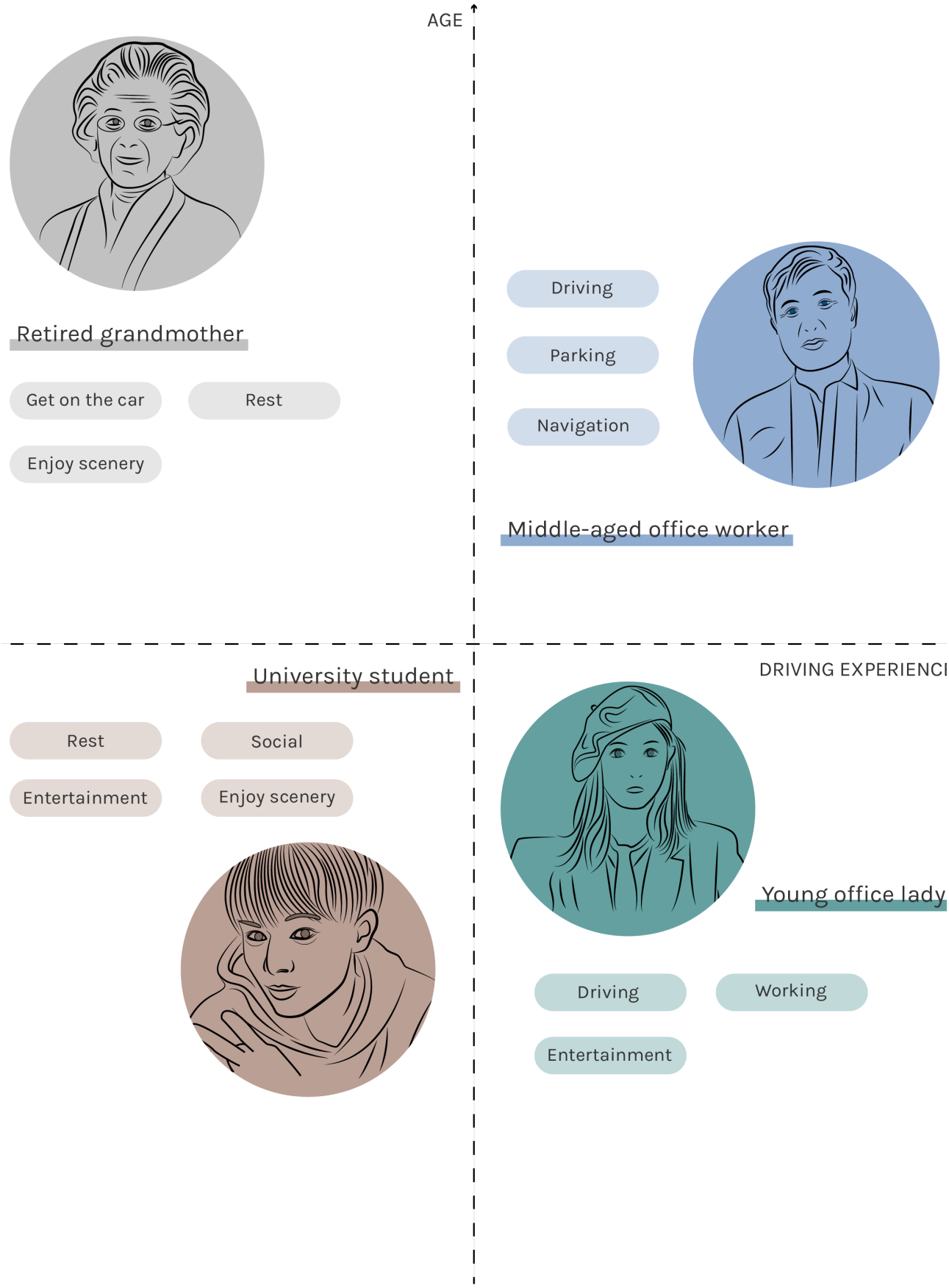


Figure 60. *According to the outcomes of the workshops, the four personas are created based on the age and driving experiences.*

University student

"I have to share the car with strangers and spend long time in the car, if there were more entertainment and I could make friends with strangers, I think the trip will be more enjoyable."

Ming is a university student and has a part-time job three times a week. To save money, he always uses the ride-hailing service or shares car with colleagues. At the weekend, he will have a barbecue party by the seaside with friends, and they will drive by themselves. He relies on social media and would like to make friends. Besides, he is addicted to games and fascinated with technology. On holiday, he will go back home by coach, and it always takes him 3 to 4 hours to go home. He usually sleeps on the coach, but he is afraid of missing his stop. Thus, he hopes that there will be more entertainment in the coach to help him consume time.

Young office lady

"I am a novice driver. But I would like to explore more places with my friends and family. It gives me a sense of achievement."

Dan bought her car recently, after having her car, she is curious about all the functions in the car. However, Dan lacks driving experience and not good at driving. To enjoy the fun of driving, she hopes to gain encouragement. Besides, she is addicted to video games and hopes that driving can be combined with games, which makes driving more entertaining. At the weekend, sometimes Dan will have a short-distance trip with her family. Exploring new places gives her a sense of achievement. Although it takes a long time, it is worth to see the incredible scenery and she will be proud if they discover excellent scenery. Furthermore, exploring new places can help her build an intimate relationship with her family. During the trip, Dan always feels curious about the scenery along the way and would like to know more about the scenery. However, even if she travels, she will take the laptop with her, in case she needs to work during the holiday.

Middle-aged office worker

"I almost drive everyday. Driving alone on my way from work is a rare time for me to relax."

Teng is a middle-aged office worker, who has more than ten years of driving experience. The car is a necessity in his life. On weekdays, he must take his children to school and drive for commuting. Because of the traffic jam, it always takes him two hours on the way. Before driving, he will check the traffic situation on the app, and he will be irritable when other drivers do not obey the traffic rules. Although he has been living in the city for 30 years, he is not familiar with every road in the city, and still needs to check the navigation before leaving, mainly when he drives and hangs out with his family on the weekend. While driving on the freeway, he would like to listen to audiobooks. Moreover, sometimes it is difficult to find parking spaces and spends plenty of time in parking.

Retired grandmother

"I look forward to the weekend trip with my family. I would like to go to places that used to bring me lots of memories."

Ying is an 80-year-old elderly. She would like to hang out and spend time with her family. Nevertheless, she cannot walk for long. Even if it is a close distance, she needs to ride. It is a pleasure for her to enjoy the scenery in the car. The car can take her to the place where she has been or takes her to a place where she has never been. However, the experience of getting on the car makes her feel embarrassed. She needs the help of other people to get on the car and is looking forward to having barrier-free facilities.

6. Discussion

6.1 Limitations of the work

Limitations of this thesis should not be left unmentioned. Firstly, a limitation of this study is time. The cooperation with the company is mainly in research stages, including desktop research and interviews. During the design stage, I stayed in China for six weeks to design the toolkit, hold workshops, and iterate the toolkit. Because of the schedule limitation, I do not have the chance to provide the toolkit to the company and apply the toolkit in a practical project.

Secondly, the majority of the participants are aged between 20 to 25, and most of the young participants do not have driving experience. Hence the participants who do not have driving experience would stand in the shoes of passengers. It is interesting to gain insights from the passengers. Although the workshop is about car usage, entertainment, and rest experience are highly ranked, instead of emphasizing driving.

Besides, one of the risks is that I might not receive objective feedback since I am familiar with some participants. Nevertheless, judging from the results, those participants also raised constructive suggestions and their confusion about the workshops. Fortunately, the relationship with me does not limit their critical thinking.

Moreover, the workshop of the middle-aged group is conducted at their private space. It might be the reason why the middle-aged group is too relaxed and have no sense of tension. I also observed that the participation of young people is generally higher than middle-aged people. The young participants are willing to discuss and actively take notes by themselves. However, the middle-aged participants preferred to let me take notes for them.

Furthermore, although the personas are created by analysing the characteristics of the participants, it is no doubt that the sample size is small, and the coverage of the sample is small. The findings of the co-design toolkit and the outcome of the workshops may not be universal. To some extent, the design concepts proposed by the participants might not be realistic or perfect. I noticed that because none of the participants has a recent purchase experience, purchase was not chosen, but this does not mean that car purchase is not essential in the whole car usage process.

Additionally, because of the limitations of the sample, the proposed potential design opportunities need to be verified and cannot be used as the final design standard. However, this thesis aims to verify whether the toolkit can effectively engage non-designers in the design process, rather than proposing polished design concepts.

Lastly, because there is no suitable workspace that can be used continuously for several days, and the participants preferred to choose the places that are convenient for themselves. The workspace of the workshops is adjusted according to the actual situation. Moreover, I was not allowed to decorate and set the workspaces in advance. The locations used as workspaces include coffeehouses, workspace in the university and the participants' private space. In addition to drinks and snacks, if possible, the workspaces can be decorated to be car-related, giving participants a sense of immersion.

6.2 Suggestions for future work

With the limitations mentioned above in mind, here are some suggestions that can take as the next steps towards practical implementation.

Firstly, further work might provide toolkit to the company and apply them to the practical project. For the company, as an innovative design approach, co-design activities and design toolkit are worth trying. Although the sample size of the present research is small, it gets plenty of insights from the users. Therefore, if the participants can be recruited through the platform of the company, more types and age groups of participants will be engaged in the co-design activities, and the findings might be more diverse.

Secondly, in this thesis, although I do not know all the participants, the members of each group know each other. Therefore, the discussion can be carried out smoothly. However, in the future, if the co-design activities need to recruit more types and age groups of participants, it should be considered how to motivate the participants and make them more active. For instance, in the introduction session of the workshops, it is significant to get participants to know the group members in a short period. Besides, as the only facilitator in the workshops, I realized that not everyone could clearly write down their ideas; thus, it would be better that each group can have a facilitator. The facilitator takes the responsibility of taking notes, immediately answering the participants' questions and efficiently facilitating the workshop process.

Thirdly, the toolkit can be designed more related to the specific project. In this study, the toolkit is designed based on the entire process of car usage scenarios, but in future work, it can be designed more targeted. The toolkit is flexible, and the “experience task” can be adjusted based on the specific project and data research. For instance, if the target users are young people, the “experience task” can emphasize young people’s habits, such as social, entertainment and games. Besides, if it is designed for the driving process, the “experience task” can highlight the behaviours that may occur during driving in detail, such as waiting for the traffic light, answering the phone and operating the infotainment system. In summary, adjusting toolkit for different projects can narrow the scope of research, and the results will be more oriented.

7. Conclusion

7.1 Answering the research questions

As stated in chapter 1, the goal of this thesis is to develop co-design toolkit for users to participate in the early stage of automotive design session and answer the research questions. The questions were studied through literature review, desktop research and verified by co-design activities.

The main question is:
How to encourage and facilitate users to participate in the early stage of automotive design ?

This thesis proves that providing design toolkit for users is beneficial for encouraging and facilitating them to participate in the early stage of automotive design.

During the research phase, the literature review verifies the importance of user engagement and indicates that co-design is a popular method to engage users. Through co-design, the company could get inspiration from the users. Among the co-design activities, design games are regarded as an efficient approach. By analysing distinctive design games, this thesis defines the goal of the design games is to provide a platform for users to share their experiences and generate ideas. Moreover, by analysing the toolkit using in the design games, this thesis frames the crucial elements for toolkit design. It clarifies that the toolkit builds a common language for the participants with different backgrounds and provide non-designers design competence.

During the design phase, the toolkit and workshops are designed based on the theories and findings from research. The shape of the toolkit refers to the card-based tools. Referring to the tools applied in various design games, the design toolkit is iterated twice. The contents of cards are designed according to the desktop research. Among the toolkit, the experience tasks are related to car usage scenarios. At the same time, the emotional cards are used to assist the participants in recalling their previous experiences and generating new ideas.

The first sub-question is:
Why are users needed to be engaged in the early stage of the automotive design ?

In answering this question, this thesis studies the benefits of engaging users in the early stage of automotive design. The literature points out that engaging users in the early stage of automotive design bring benefits to economic and brand image (Francois, et al., 2017). Besides, listening to users' ideas can better understand their needs and meet expectations (Von Hippel, 2001). Moreover, in the automotive design field, the users are encouraged to share their ideas during the design process, instead of only involving the users in the concept assessment and usability session. In addition to the literature review, through the expert interviews, the experts are positive about user engagement and would like to try to engage users in in-vehicle design.

The second sub-question is:
b) What kinds of co-design tools and activities will be appropriate for engaging users in the early stage of automotive design?

In this thesis, through the twice iteration, the workshops tested the usability and practicability of the toolkit. The final design toolkit includes experience tasks and emotional cards. Beginning from choosing experiences, the participants could quickly immerse themselves in specific scenarios. The chosen experiences reflect the experience that users pay more attention. In other words, the highly ranked experiences could guide future design. By discussing with the group members, the participants can think more deeply. Besides, the emotional cards assist as an origin of inspiration for participants to communicate.

Negative emotions act as triggers to help participants recall the current problems, while the positive emotion cards excavate the users' subconscious to derive more specific needs. After choosing cards, the individual work is followed by group discussions which stimulate the participants to produce more ideas in a short time. During the discussion, the participants are asked to take notes. Listing the current problems and expectations could help the participants to recall their earlier discussion. In summary, toolkit assists the participants to narrow down the scope of car usage and guide them to focus on specific experiences. Therefore, the final design concepts could be more specific and reveal the participants' expectations, although the concepts are not polished.

7.2 Personal reflections

Personally, during the two-years study at Aalto University, co-design has had a profound influence on me. Before the master's study, I knew nothing about co-design. However, during the master's study, I became interested in co-design and took it as the research topic of this master thesis. Through working on this thesis project, I got a deeper understanding of co-design. I regard the process of the thesis as a learning experience. From the aspect of the theory, the literature review gives me a more systematic understanding of co-design. Through the desktop research and expert interviews, I try to gain more knowledge of the automotive design field, which I am not familiar with. In the design stage, I attempt to combine the co-design theory with a practical project, which makes the research more meaningful as well as improve the design of the toolkit through two iterations. Look back to the objectives mentioned in Chapter 1, in the end, I am capable of stating that these goals were fulfilled.

As the only designer and researcher in the project, I was forced to overcome my shortcomings. During the two-years study, I have done plenty of group projects; however, recruiting participants and running a workshop by myself remain difficult. I was compelled to take notes, observe and facilitate the workshop at the same time. Although it makes me feel exhausted, it is a chance to increase my confidence in my abilities and skills as a designer.

Besides, automotive design is a brand-new field for me. During the internship, I started to learn about the automotive industry. After understanding the current design process of the company, I decided to study how to combine the knowledge I have learned to make co-design play a role in automotive design. In addition, I am thankful for the support provided by the company. Before starting this topic, I have discussed the topic with the head of the Experience and Interaction Design Department. He approved my research direction and encouraged me to explore new methods for UX design. Due to the limitation of the schedule, although I did not have a chance to conduct field visits, the experts were actively involved in the remote interview and warmly answered my questions. With the support of the company, the project can be carried out more smoothly and efficiently.

I am glad to take this project and satisfied with the outcomes. I will bring these experiences and learnings to my future work in co-design.

Acknowledgments

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At Aalto University, I would like to extend my sincere gratitude to my supervisor and advisor, Professor Andrés Lucero, for his instructive guidance during the thesis process. I am deeply grateful of his help in the completion of this thesis.

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Figure 5. Mercedes-Benz AG, n.d. Available at:<https://www.mercedes-benz.com/en/vehicles/transporter/vision-urbanetic-the-mobility-of-the-future/> [Accessed 10 March 2020]

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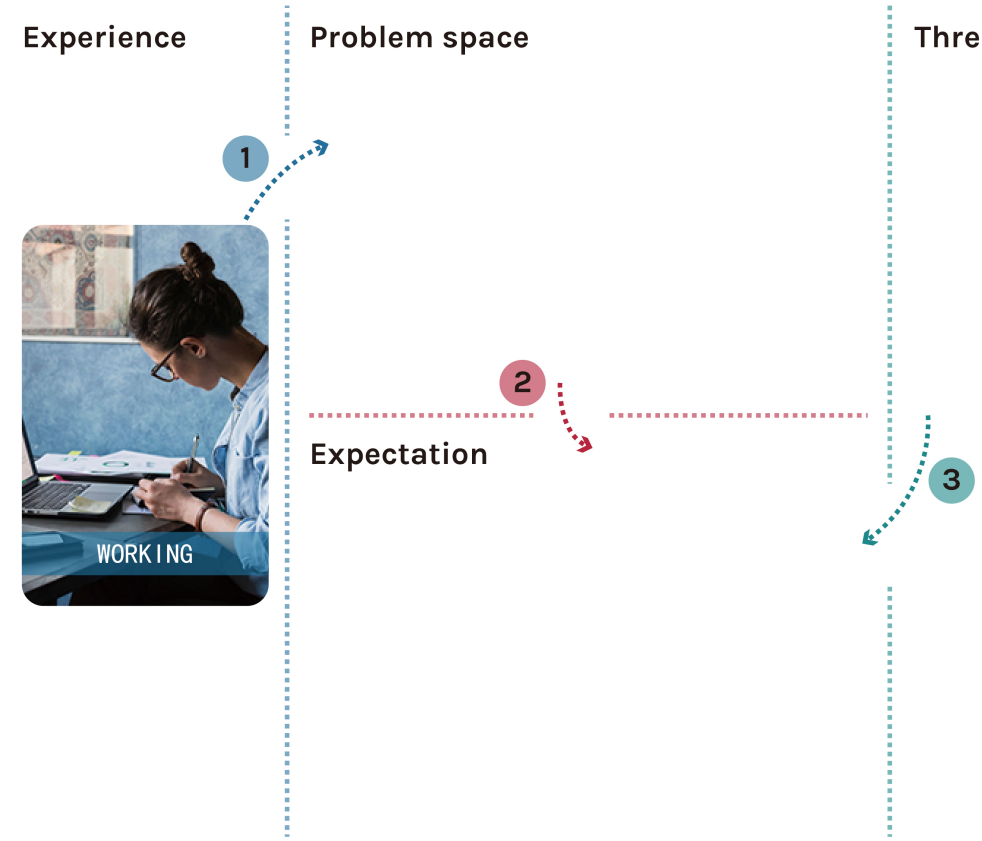
Appendices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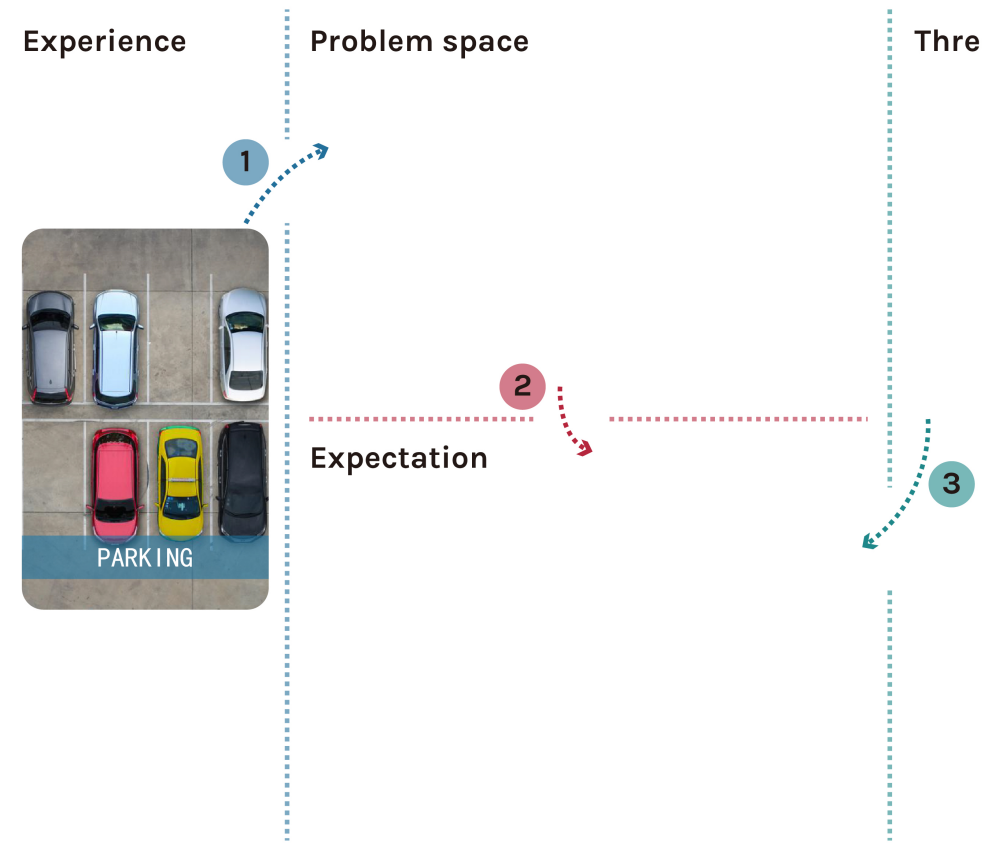
WORKING
2
Expectation
3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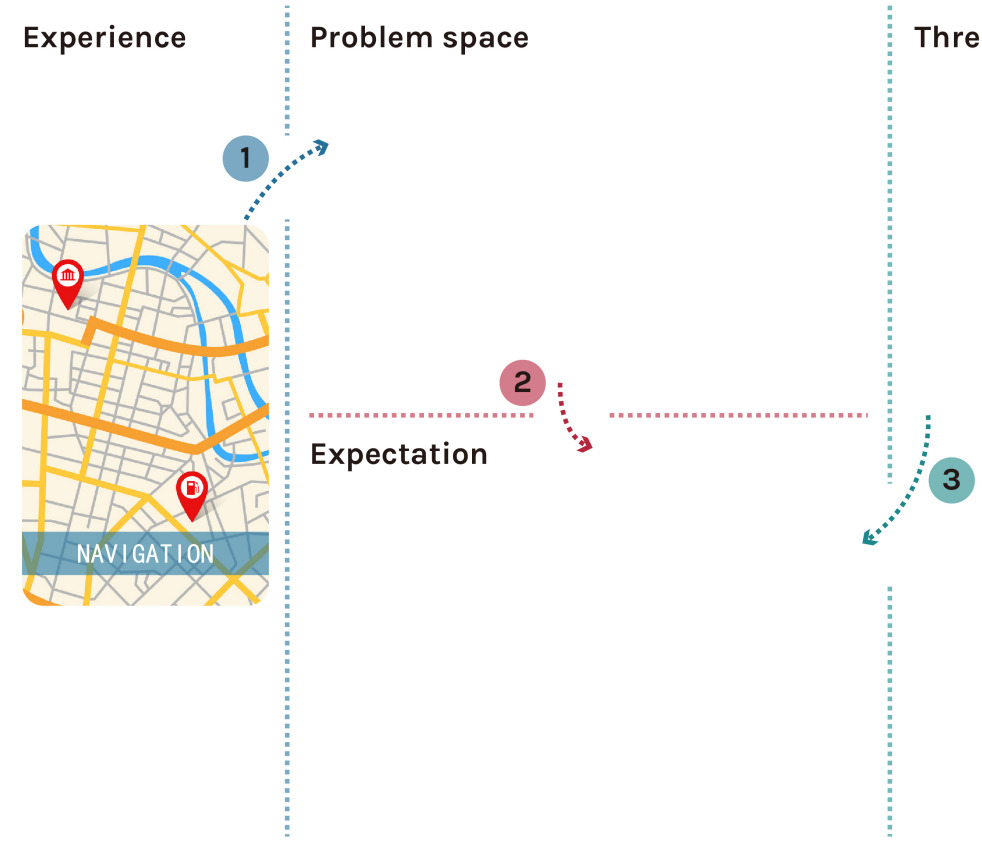
Problem space
Three magics
1
PARKING
2
Expectation
3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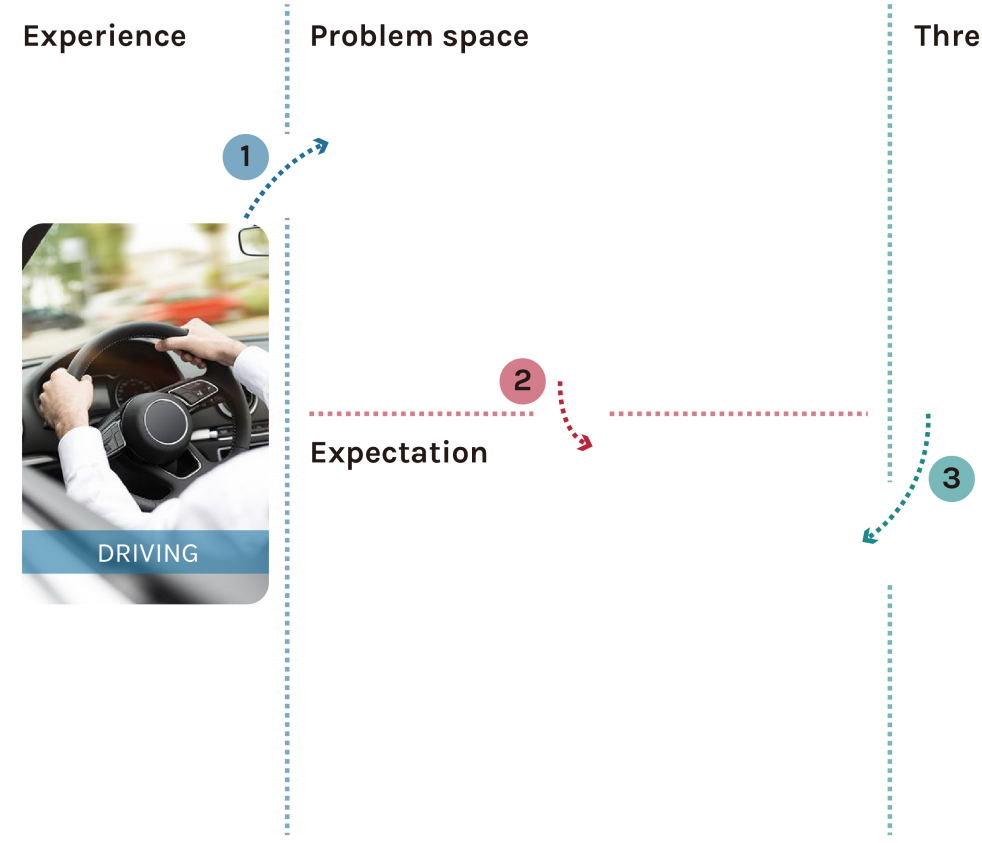
Three magics
1
NAVIGATION
2
Expectation
3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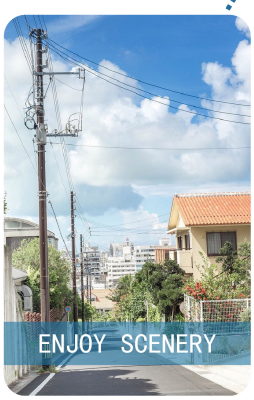
Problem space
Three magics
1
DRIVING
2
Expectation
3

Experience

Problem space

Three magics

1



2

Expectation

3

Experience

Problem space

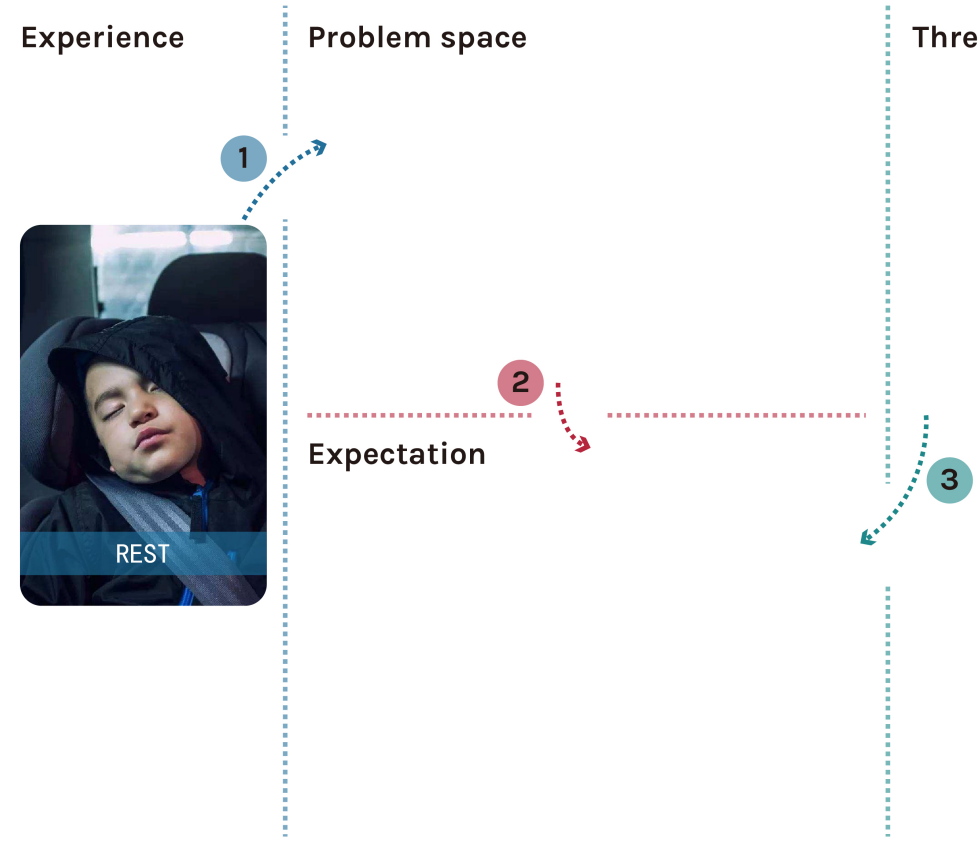
Three magics

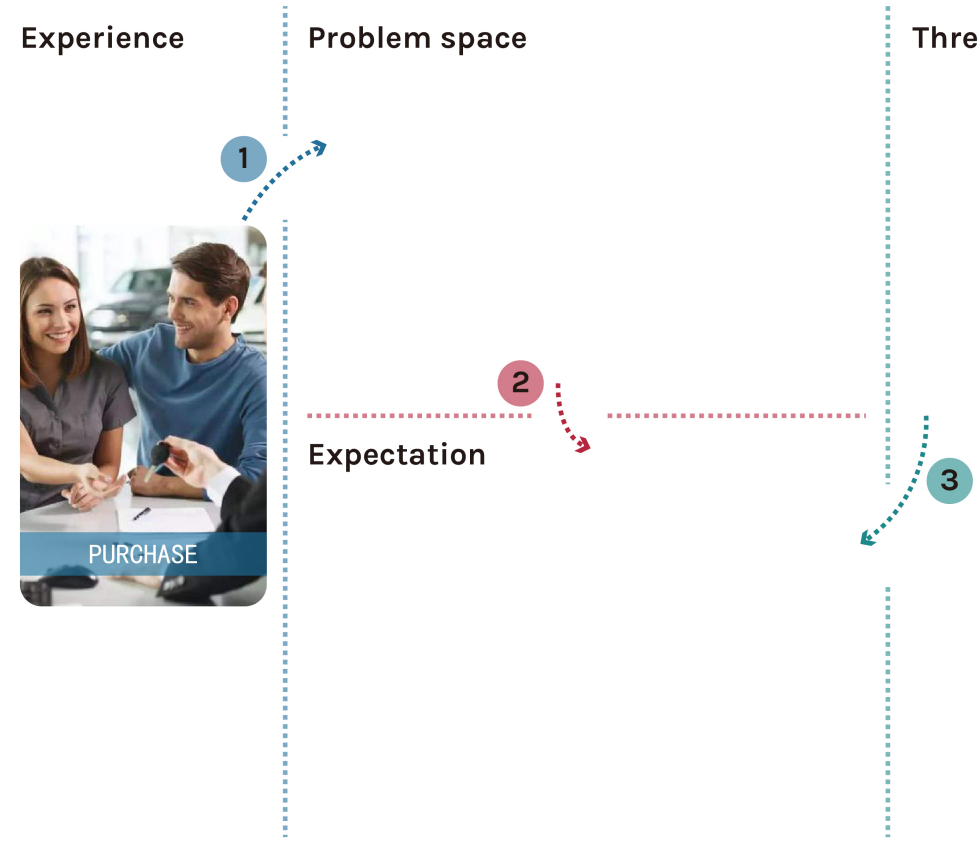
1

2

Expectation

3


Experience
Problem space
Three magics
1
REST
2
Expectation
3

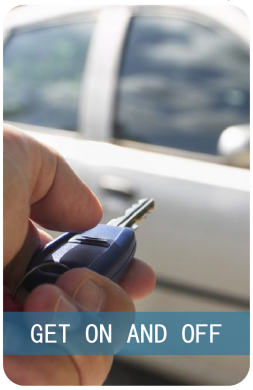

Experience
Problem space
Three magics
1
PURCHASE
2
Expectation
3

Experience

Problem space

Three magics

1



2

Expectation

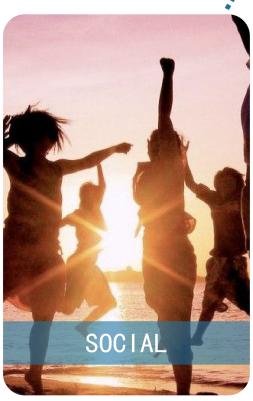
3

Experience

Problem space

Three magics

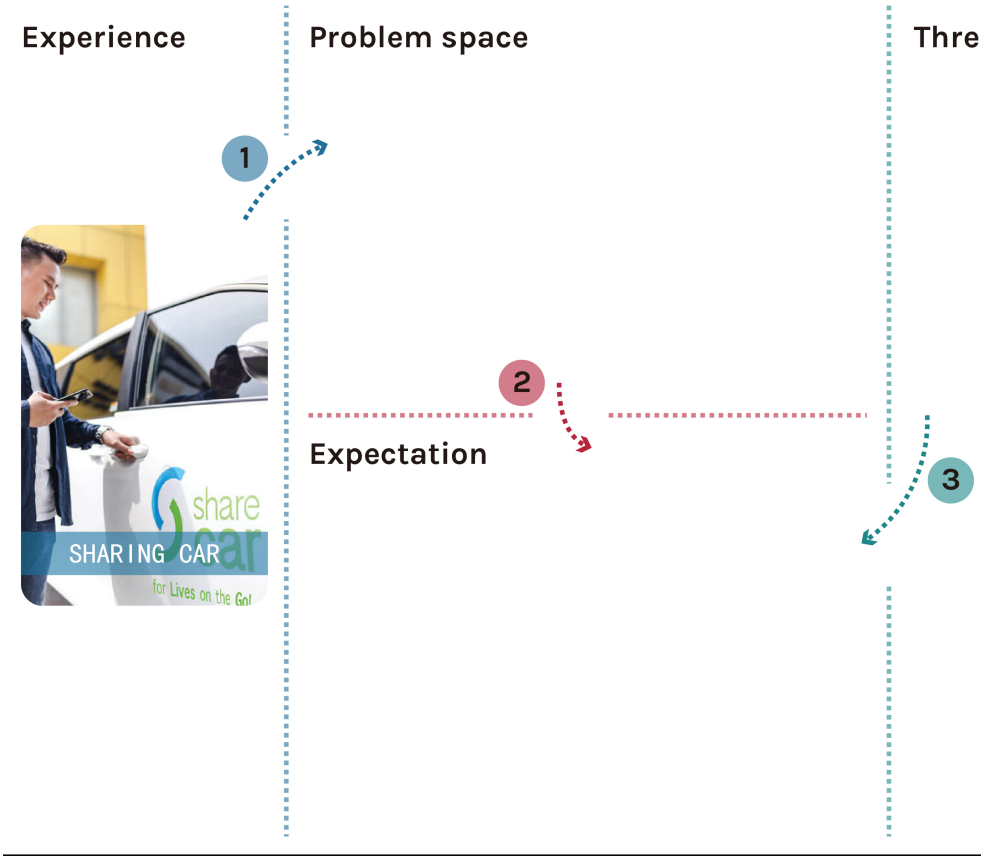
1



2

Expectation

3


Experience
Problem space
Three magics
1
2
Expectation
3
share car
SHARING CAR
for Lives on the Go!

Introduction to Research Project

This research intends to record and capture feedback to workshop process. It is conducted by a researcher as part of the Master's thesis MUO.thes course within the program of Collaborative and Industrial Design, Aalto University. You will be required to share your thoughts and ideas during the workshop. You will work and discuss with other participants. The researcher will like to record the workshop process; however, you can opt out of this before or during the workshop process.

Informed consent to participate in a research

I agree to take part in this workshop. I have also been able to ask questions about the research.

I give permission *(please tick):*
[ ] to be recorded on audio and photos for the duration of the workshop.
[ ] for the data collected to be used within the course & any other course-related activities.
[ ] for the results of the workshop to be included in any future portfolios or publications by the research team.

I understand that participation in this interview is entirely voluntary and I can withdraw my consent and discontinue participation in the research at any given moment before its completion. I am also aware that the data collected up to withdrawal will be used as part of the research data. I give my consent to participation in this research;

Name:_____

Signature:_____

Date: _____

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Collaborative and Industrial Design
School of Design
Aalto University

The consent form. In the workshop, it is translated into Chinese.